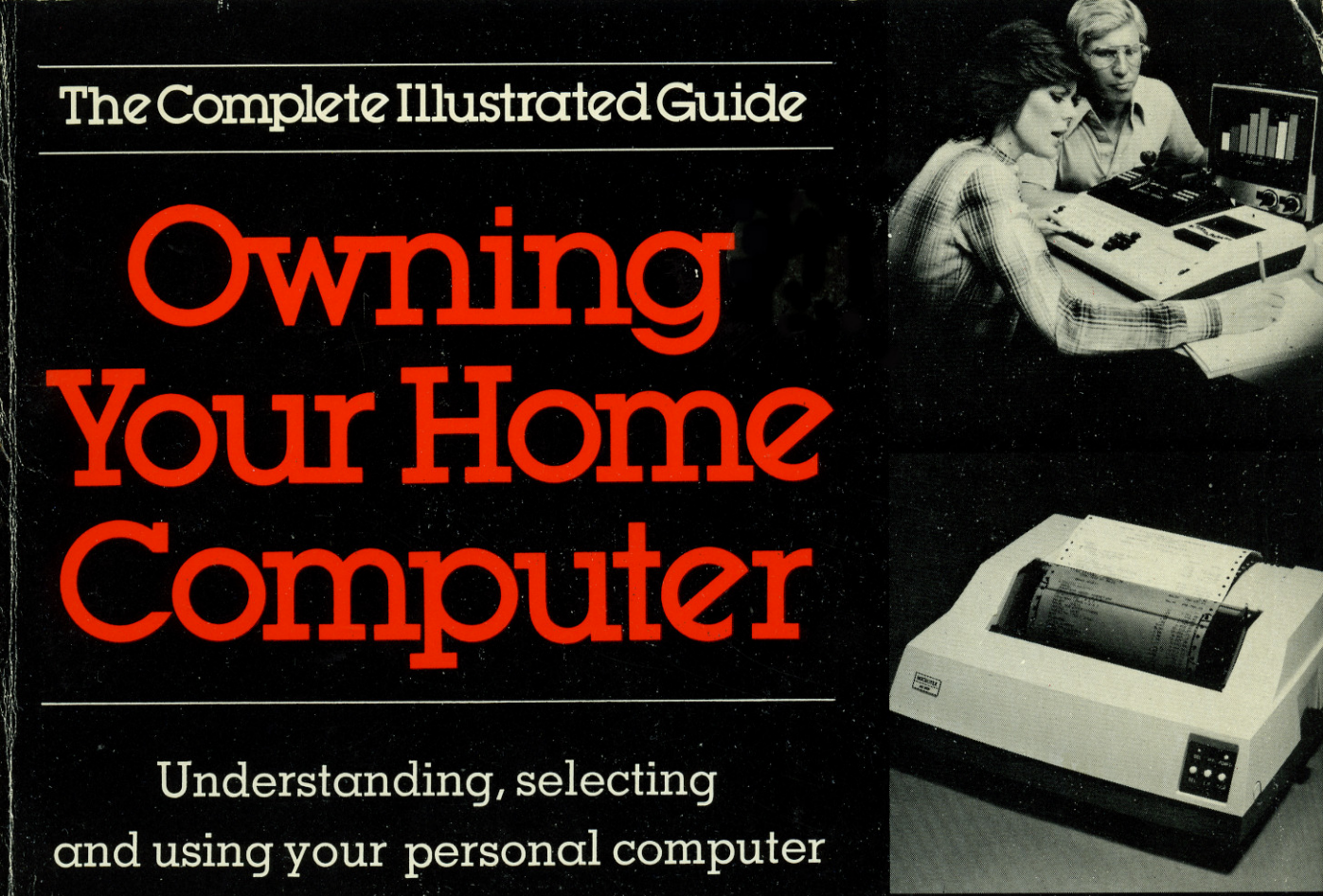
The Complete Illustrated Guide

Owning Your Home Computer

Understanding, selecting
and using your personal computer
for business, entertainment
and education.
Plus a separate listing of
over 1,000 programs now available.

Robert L. Perry



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THE COMPLETE ILLUSTRATED GUIDE

Robert L. Perry

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To Joseph Daffron and Ronald Renzulli, who,
each in his own way, made this book possible

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It's not possible in this short space to name everyone involved in making this book possible, but to every company and every person who contributed material to this book I extend my thanks.

Finishing a book always seems to occur at the worst possible time, yet those directly involved always rise to the occasion. Finishing this book was no exception. Those who did more than their share and enabled me to finish this book despite bad weather and the 1980 New York flu epidemic were my administrative assistant, Mrs. Sirje Uriko, who spent long hours typing the manuscript and Mrs. Edith Barr, who did an excellent and professional job of proofreading the final copy.

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ROBERT L. PERRY
Cavan, Navan & Kells
Custom Journalists
May 1980

PART ONE

The World at Your Fingertips

1. The Home Information Explosion

PRACTICALLY EVERYONE HAS SEEN or heard about "home computers" during the past few years. Most people, however, take a look, say, "That's nice," and promptly forget about them until they see them again on television or read about them in magazines. As a friend said when I began writing this book, "Home computers? I've seen them, but what good are they?"

That phrase has echoed through history when skeptics have not seen the possibilities of inventions that we take for granted today. The world scoffed at Alexander Graham Bell—"The telephone is just a toy"—and derided Thomas Edison for the electric light, the phonograph, and the moving picture projector. But today, you can pick up any phone, dial 11 or 12 numbers, and reach any country in the world directly. You can flip a switch in your home and any of 10,000 different home appliances will automatically come on. Press another button and that appliance will perform its task quickly and efficiently without your help. And when you pull a knob or press a button and turn a channel, you can watch whatever is happening, while it's happening, on the other side of the moon or in your own backyard.

You can consider that home computers are as crude today as telephones were about the turn of the century. But a major difference separates home computers from the first telephones and electric lights. No telephone network existed, no transmitters or receivers were being manufactured, no electric power network existed to carry the signals (this is the main reason that the telephone has always had an independent power supply). Edison faced the same vacuum: no generating plants; no lines; no customers; no known demand; no electrical appliances; no wall switches or outlets in the home.

At the touch of a button, however, today you can link your home computer to your telephone and "talk" to another computer on the other side of the world, or to your best friend's computer just across town. Unlike telephones and electric lights, home computers have developed from the top down. Big computers came first (as we'll see in detail in Chapter 3). Whether that helped or hindered the development of home computers excites furious debate among the experts. The fact remains, however, that IBM, Burroughs, Control Data, Texas Instruments, and many others first developed big computers called *mainframes* for government and big business. That made good sense. You can't use in your home a computer as large as your bedroom, but Social Security, the Internal Revenue Service, and Exxon can.

Researchers then discovered how to put computer circuits on a chip of silicon smaller than a fingernail, and the current electronics revolution began in earnest. In five years, more than 70 million people bought pocket calculators, proving that adults did want easier, quicker ways to do their work, and children wanted the same advantages in completing their school assignments. And a pocket calculator was something the owner could completely master in minutes. Soon researchers learned to put a complete computer on an even smaller chip.

At the same time, another revolution, closely related to the calculator revolution, exploded: the Information Revolution. As almost every

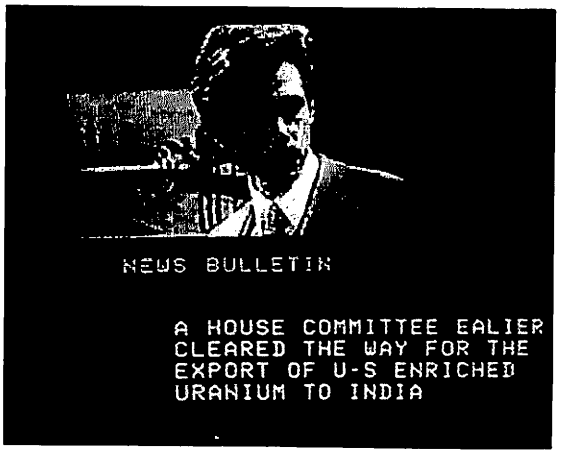
large and medium-sized business and government agency required computers, they learned they could generate enormous amounts of information about any subject they wanted to—and they did. Electronics companies developed incredibly sophisticated communications networks, and American Telephone & Telegraph—along with satellite companies—obligingly created millions of telephone lines to carry these masses of information. Within the past several years, the tiny computers-on-a-chip have been put into some new telephones and many other communications devices at very low prices.

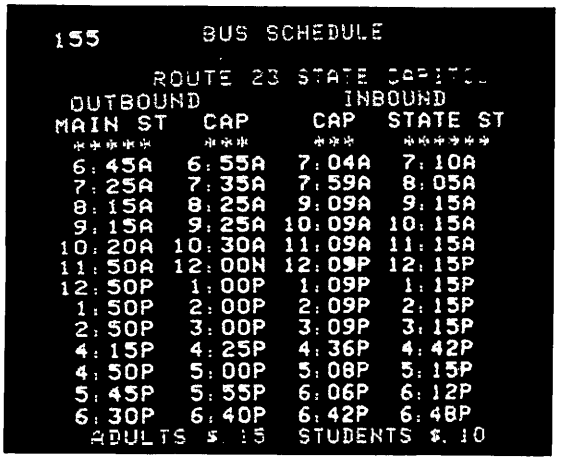
As these trends occurred simultaneously, innovative computer engineers built the first crude home computers. The first one was little more than a plastic board with complicated circuitry and buglike chips stuck onto it. To use it, you had to know as much about computing as Alexander Graham Bell knew about telephones in 1876.

But that rapidly changed as dozens of bright young men and women began making increasingly sophisticated and increasingly easy-to-use home computers. And millions of people began to wonder what they could do with these machines, although the mere word "computer" continued to strike a deep fear in many hearts.

The answer to that central question began to emerge from several strange sources. In Great Britain, in 1974, the British Post Office (which runs that nation's telephone system, too) began experiments with two exciting ways to put enormous amounts of information onto home television screens: Teletext, called CEEFAX and Oracle, and Videotext, also called Prestel or Viewdata. Both heralded the first barrage in an information explosion that promises to change your life in many fundamental, yet very positive, ways.

Teletext, simple, cheap, and free (to the home viewer), transmits about 300 pages of printed material over an unused portion or "blank space" in a television signal to a home TV. The signal, which arrives along with the regular picture, remains invisible until you punch numbers into an encoder, actually a keypad the size and shape of a pocket calculator. Then the printed material becomes superimposed on the screen, and you can read any of the 300 pages of material and watch your favorite programs at the same time. More than 45,000 British viewers can now choose from dozens of kinds of information: news, sports results, stock market





Two examples of how Teletext "pages" appear on a home television screen. One shows a news bulletin superimposed on a broadcast, which continues to be shown, while the other illustrates how full "pages" of text fill the home television screen at the touch of a simple keypad. (Courtesy of Bonneville International, Inc., KSL, Salt Lake City, Utah)

prices, classified advertising, weather and traffic reports, real estate listings, home-study courses, and much more.

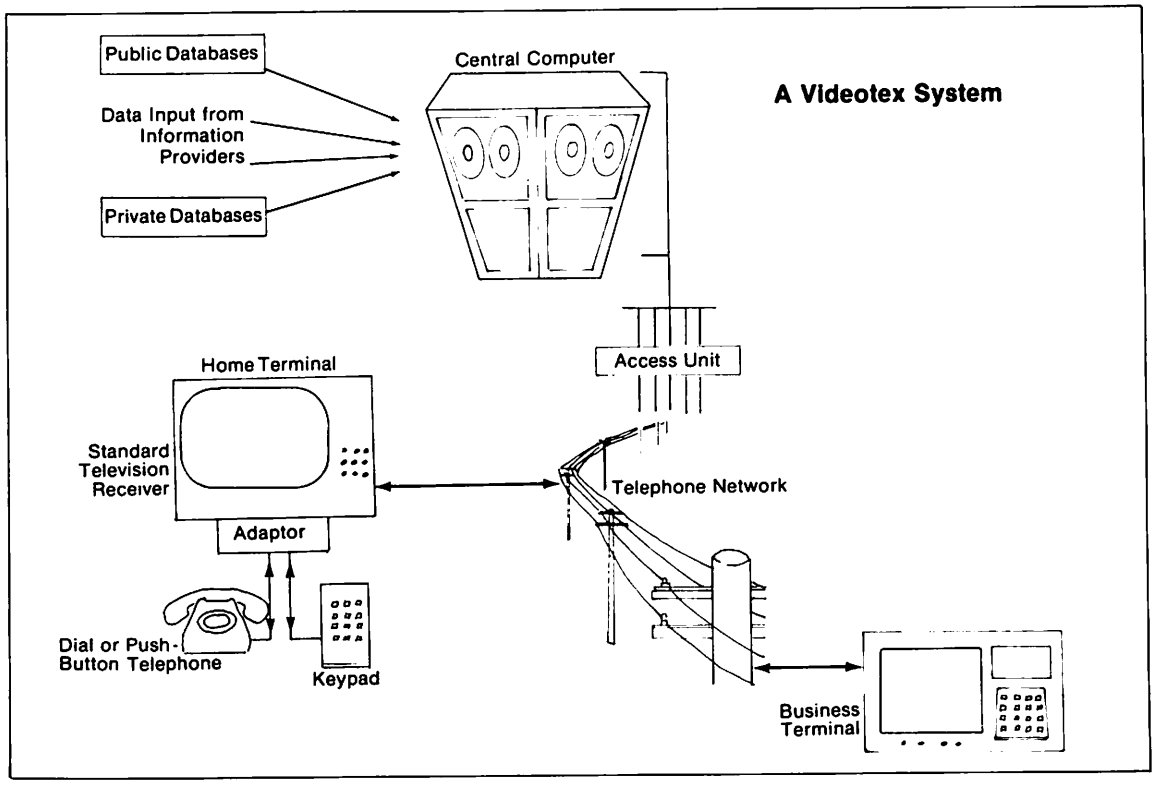
Teletext serves as an electronic newspaper, encyclopedia, dictionary, and aid to the deaf—subtitles can easily be shown through Teletext for each program on each channel. Two U.S. television stations—KMOX (a CBS affiliate) in St. Louis, and an independent station, KSL, in Salt Lake City—have tested Teletext for more than a year. Both tests, however, consisted of in-house transmissions, and local station engineers received all the Teletext information. Both stations may decide to introduce Teletext commercially in 1981. And Teletext-based systems are being tested in half a dozen other Western countries; in France, it's called Antiope.

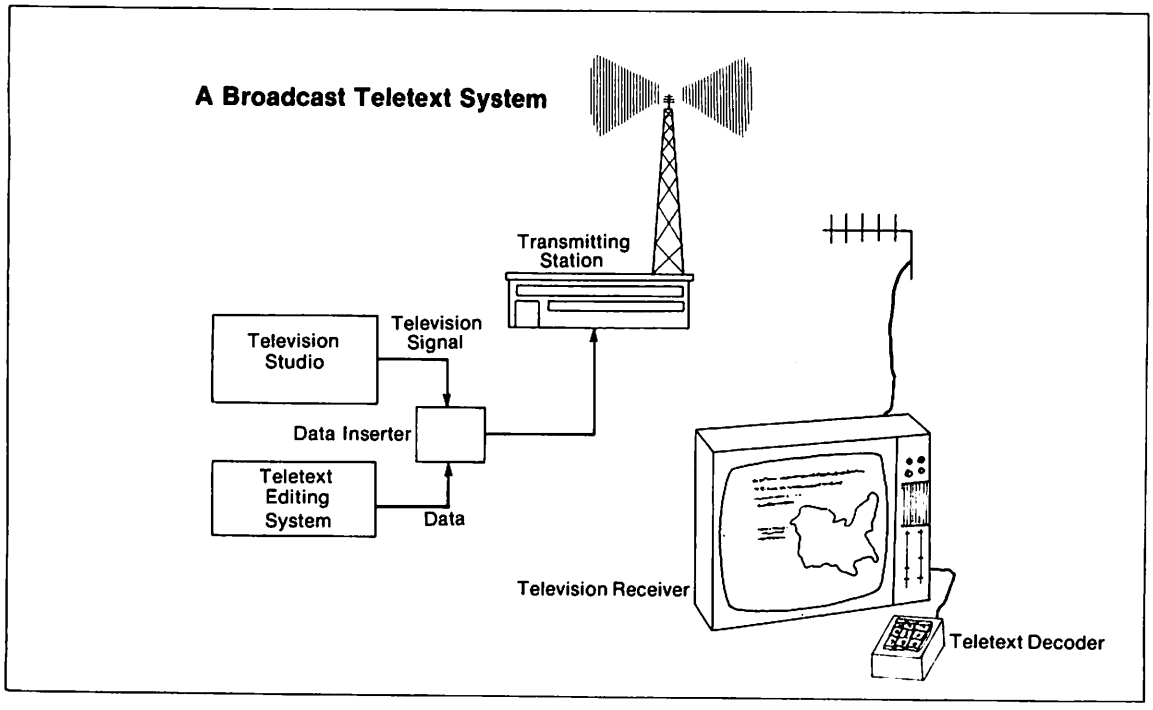
But Teletext has one significant drawback: you cannot interact with it. Using Teletext, a viewer remains passive, pressing buttons on a keypad to call up information to the screen. In many areas of the United States today, you can get many of the same services by turning the channels on cable television. News, weather, sports, stock market prices, television and radio logs, and radio stations now all come over many cable channels.

The Viewdata Difference

While Teletext lights a firecracker in the information explosion, Viewdata launches a rocket. Viewdata allows viewers to call up—through a simple keypad or typewriterlike keyboard and a

Block diagram of a Videotext system such as Viewdata. Knight-Ritter Newspapers, Inc. and American Telephone & Telegraph conducted the most significant test of Viewdata services in this country during 1980. (Courtesy of Institute for the Future)





Block diagram of a broadcast Teletext system, such as Britain's CEEFAX and Oracle, and France's Antiope. (Courtesy of Institute for the Future)

telephone—any of the information a Teletext system can provide, but lets the viewer respond to the information. The Viewdata keyboard and a telephone work through an adapter, which sits on top of the TV set (or can be built into the set, which seems more likely). Louis Burke, Manager, Systems Development–Residences, for American Telephone & Telegraph, quotes a French expert who says that such an adapter could be built into new TVs or added to existing ones for about $100.

With that adapter and keyboard, you could order from a mail order catalog on the TV screen, vote in an instant public opinion poll, order from a local food store, do your banking and bill paying, and review a list of real estate offerings and ask for more information about specific houses. As the experts agree, these interactive ways to use Viewdata seem quite conventional and crude. Many have said they have no idea what the public will really want to do with Viewdata. In any case, if you can think of ways to make your life easier and save time for things you really want to do (who really likes walking up and down grocery store aisles on Thursday or Friday nights?), you can probably think of new ways to use Viewdata.

Viewdata services work through the telephone lines, instead of through "blank space" within a television signal. A central company puts together a number of large computers into which information providers feed masses of information. At home, you punch a number on the keyboard—like using a Touch-Tone® phone—and make a regular phone call to the computer. The computer answers and begins sending your TV a *bit stream,* or flow of digital information. Your TV adapter receives this flow and converts it into printed text on the TV screen. But because the information comes in over a phone line, you can reply, using the keyboard to instruct the computer. In effect, your

keyboard—which contains a tiny computer—carries on a computer-to-computer conversation.

With Viewdata, however, you cannot receive TV signals at the same time you hook up your TV screen to the Viewdata service. Viewdata pages are shown against a blank screen, so you can't watch "M*A*S*H" while you order milk from your grocer. But Viewdata has a potentially unlimited storage capacity.

QUBE: The First U.S. Viewdata

Viewdata was invented in Great Britain in 1970 by a Post Office employee who wanted to encourage the British to use their telephones more often and increase the Post Office's revenues. Amazingly, the average person in Britain only made about one and a half calls a day in 1970. Most Americans make half a dozen or more calls a day, and people in business use the phones all day long.

As the British tests continued through 1977, Warner Communications Cable Corporation announced the first test of a U.S. Viewdata-type system. Called QUBE, its testing began over one of Warner's cable television stations late in 1977, with 100,000 families in Columbus, Ohio. It works similarly to Viewdata, but it sends digital flows of information along unused cable television channels. And it uses a simple home terminal with just a few buttons.

QUBE has been called "participatory television" and has so far relied on regular television programs to which viewers can respond. For example, a show called "Columbus Alive!" carries a TV "tag sale" or "auction of the air," in which a seller can display an item for sale and get from QUBE an instant printed list of viewers who have bid for the item. Other participatory programs have included requests from teenagers for a televised dance party and viewers participating in quiz and game shows.

QUBE marries the TV and the computer. Four mainframe computers scan the cable system every six seconds, recording which sets are turned on and to which channels they are tuned. The computers automatically bill viewers who watch the interactive programs, which Warner calls "pay-premium" programs. The computer also instantly counts the results of any survey or poll and shows them on the screen. It can also activate fire, burglary, and other emergency alarm services through an additional device, the home terminal and the main computer.

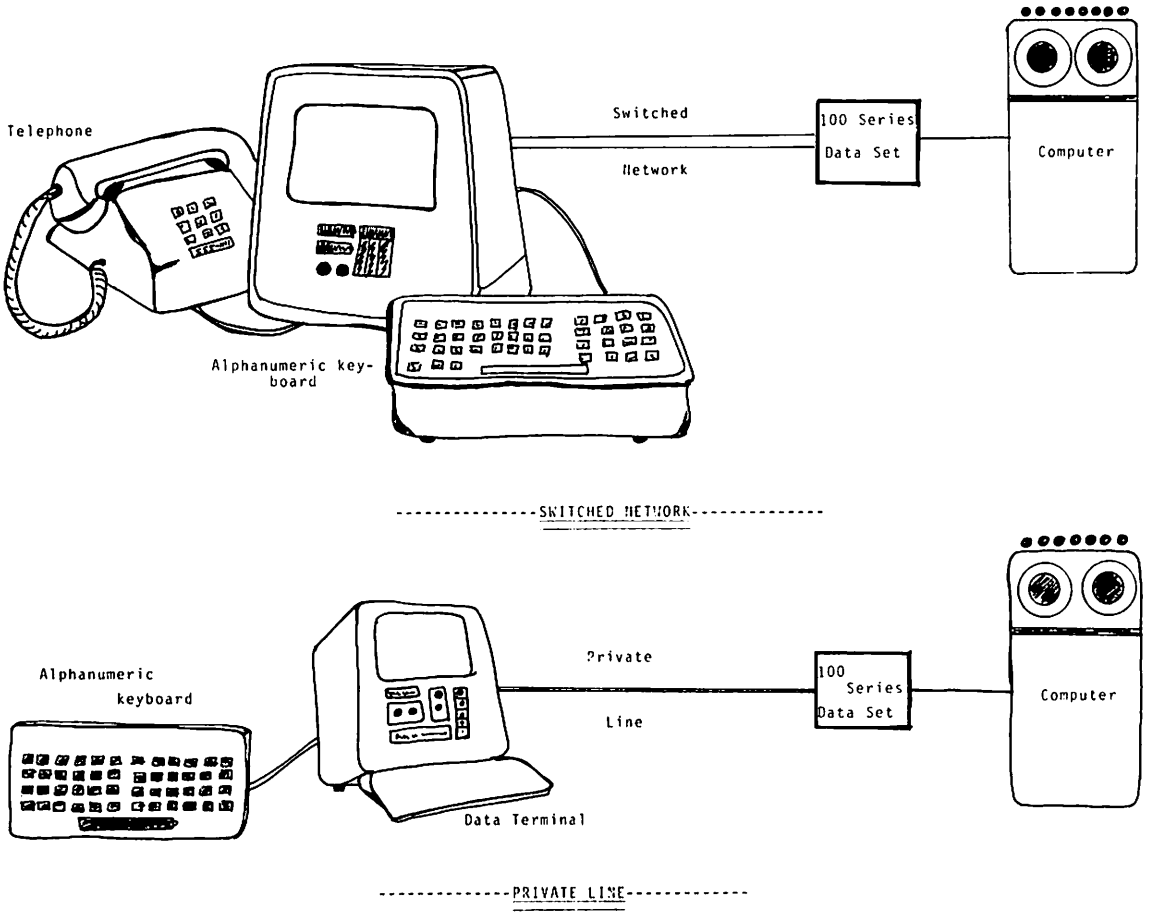
But because QUBE runs on cable television, viewers must pay for what they get. Subscribers get regular TV and community programs for a monthly charge; they pay extra for each pay-premium program they watch. And QUBE watching can become expensive. One estimate for a weekly movie, a TV special, a sports event, and a monthly concert or home-study course amounts to $50 a month plus an $11-a-month cable charge.

QUBE's interactive aspects appear limited compared to Viewdata's potential. Its viewers punch numbers and codes merely to answer multiple choice questions or to signify "Yes" or "No" or "Right" or "Wrong" on a survey or poll; they place orders or request more complete information. On the other hand, QUBE operates while the cable station broadcasts the program; responses may be shown on the screen or announced to the audience.

The Most Significant Viewdata Test

As Warner's QUBE expands its services in 1981 to Texas, Knight-Ritter Newspapers and American Telephone & Telegraph have ended the most important test of "true" Viewdata ever conducted in the United States. Since spring 1980, more than 300 families have experimented with an AT&T home terminal and a huge information bank coordinated by Knight-Ritter as information provider.

Knight-Ritter rented space in its mainframe computer to an impressive array of information sources: Consumers Union, Macmillan, Inc. (a major publisher), the Associated Press, Ad-



Block diagram of AT&T's Vu-Set visual display service, which resembles the system AT&T used in its Florida Viewdata tests in 1980. The Vu-Set was introduced in 1978 for business and commercial applications, and the AT&T Viewdata terminal more closely resembled a full computer terminal and typewriter keyboard.

dison-Wesley (an educational publisher), *The Economist* magazine of London, a Miami liquor store, a group of local realtors, J. C. Penney, and many more. (A complete discussion of these interactive systems appears in Chapter 8.)

AT&T developed two kinds of home terminal: a simple, hand-held, calculatorlike keypad, which also resembles a Touch-Tone® phone, and a regular typewriterlike keyboard, like those found on home computers. Both have a standard microcomputer chip. AT&T also made the experimental adaptors that are attached to RCA color televisions.

Their Viewdata system makes available more than 10,000 "frames" of information and works like the regular Viewdata system. Like QUBE, it can test or poll consumer reaction, but it also allows for more interaction. It includes simple graphics, enabling users to draw simple pictures on the screen and transmit them to the computer. It allows for ordering from catalogs, although AT&T's Louis Burke acknowledges that the Florida test does not go far beyond what British Viewdata has already accomplished. AT&T has deliberately kept the test simple and

limited to determine how the 150 families felt about the system and what they wanted to use it for.

The potential, as Burke and many other experts see it, boggles the imagination. One simple example: You want to go to an Italian restaurant for dinner. In a simple system, you would have to search through several "menus," or lists of available restaurants: first, a list of all restaurants in town; second, a list of Italian restaurants by type—pizza, northern, Sicilian, and so on; third, a list by geographic location (north, south, east, or west side of town); and so on until you came to the four or five Italian restaurants that fit your specifications. Instead, you'd probably either look up restaurants in the Yellow Pages® or skip the whole thing. But Burke and others believe you would willingly type into a terminal the simple specifications: "Northern Italian, south, $10–$20 per person." And the Viewdata computer would instantly give you a list of restaurants that fit your categories.

William Wulff, a top computer theoretician, says—and many professionals would agree—that although he doesn't want the Library of Congress (or its equivalent) lining his book

A man demonstrates how easy it is to use the MicroNET home information utility with a simple home computer like the TRS-80 from Radio Shack. The TRS-80 gains access to the network through the telephone, which rests in an acoustic coupler modem. The modem translates computer signals into telephone signals and vice versa, so that the two computers can "understand" each other. MicroNET can be used with a local telephone call in 175 cities in the United States from 6:00 P.M. to 5:00 A.M. weekdays and all day on Saturdays, Sundays, and holidays. (Courtesy of Compuserve Corporation)

shelves, he does want access to it. Viewdata home computers and information networks can easily make that access possible.

AT&T and Knight-Ritter will evaluate their test results in 1981. If they eventually conclude that the public would buy Viewdata and use its mostly free services (an important difference from QUBE), the impact by 1985 could dwarf anything that has been imagined so far. AT&T obviously has the billions of dollars necessary to put a home terminal beside every one of its 100 million telephones, and Knight-Ritter and every other large publisher can provide immense amounts of information. And local businessmen would willingly pay for space on the TV screens of hundreds of thousands of homeowners.

The First and Second Home Information Services

But you have a further surprise in store. While the communications giants tread slowly and softly into home information services such as Teletext, QUBE, and Viewdata, two home information utilities with all the services of these three—and much more—have offered commercial service for more than a year. In short, you don't have to wait until your cable company starts QUBE, or a large TV network offers Teletext, or a communications giant (General Telephone and Telegraph also has tested Viewdata) mass produces home terminals and assembles huge libraries.

The SOURCE from Telecomputing Corporation of America and MicroNET from Compuserve Corporation already provide these libraries. For example, the SOURCE, with a phone call, links you with the New York Times Consumer Information Bank, all of the United Press International news, more than 3,000 computer programs, hundreds of games, an electronic mail system, a travel club, a money-saving buyer's service, a horoscope service, national real estate locator services, business and financial information from the stock and financial markets, and access to computer languages.

MicroNET provides a nationwide community bulletin board service, dozens of computer games, shop-at-home services, corporate financial information, encyclopedia and dictionary services, airline scheduling and ticket services, and more. The cost of each is very reasonable compared to the cost of a long-distance telephone call: $2.75 an hour for the SOURCE and $5 an hour for MicroNET. (These prices may change or fluctuate over time.) Try talking to your grandmother in Ninnewaska for an hour and see what the phone bill is!

What's more, you can use these services with a simple home computer or terminal and a device called a telephone *modem.* Both services work through the telephone lines; a telephone modem simply takes digital information from a home computer or terminal, translates it into telephone signals, and transmits it to another modem inside each company's mainframe computers. The telephone network that both use is the Tymshare and Telenet communications network and *packet-switching* service. Packet-switching services send very rapid bursts of digital information along long-distance telephone lines. The information transmission occurs in *packets* in between the pulses of signals carrying telephone calls.

In Chapter 7, you'll see how easily you can hook up to these two home information utilities and take advantage of the amazing amounts of information you can control now.

The EIES Has It in Information Networks

People who have used the SOURCE and MicroNET so far favor their electronic mail and community bulletin board services. It seems that while people enjoy interacting with computer programs or playing computer games, they'd prefer to use the information services to keep in touch with people on the other side of the country—without the cost, time, or trouble of placing unanswered calls, dialing wrong

numbers, and failing to reach the person they're trying to reach. And the bulletin board and electronic mails cost *less* than the phone company (a fact with which the phone companies are well acquainted).

Neither of the first two information utilities lets someone "talk" electronically to someone else directly. But MicroNET has a "CB" function—modeled after Citizens Band radio—through which groups of people with 3–14 members can establish a private, "real-time" network of members of its network.

EIES can do much more. EIES stands for Electronic Information Exchange System, a remarkable computer network founded by Dr. Murray Turoff at the New Jersey Institute of Technology. At present, more than 700 people in North America and Europe "talk," leave messages, hold conferences, write articles, academic papers, and proposals, and generally carry out most normal social activities without ever seeing each other, by hooking up to the computer network at the same time.

EIES began, in 1977, to experiment with computerized conferencing and personal information networks among groups of people with varied professional, business, and personal interests. Each EIES user links to a Perkin-Elmer minicomputer with a telephone modem and either an inexpensive terminal and a printer without a TV screen, or a personal computer with a TV screen and a printer. Anyone can use the EIES network at any time and communicate with any other EIES network member.

Dr. Turoff has called EIES "a blooming, buzzing garden" of social activities.

Computer communications through EIES have shown that people and their natural sociability triumph over distance, time, and computers. EIES has become a microcosm of society, but it has also created new ways for people to work together and relate to each other. For example, people send birthday, wedding, and holiday wishes, share vacation plans, and announce births, deaths, and other family events through the system. And many people have checked the EIES member directory to find dinner companions when they visit new cities. And, inevitably, spouses of EIES members use the system itself to share ways to cope with spouses addicted to EIES. The list of people making contact in unique ways with people they've never met in person goes on and on.

But EIES is only the largest of more than two dozen electronic information exchanges. Throughout the country, home computer owners have formed small networks to share information about computers, play computer games, and act as community bulletin boards for people with similar interests. And all of these systems are inexpensive compared to a long-distance telephone call. EIES at present costs the users about $7 an hour; that includes about $3 an hour that EIES charges and $3.75 an hour to use the GTE Telenet packet-switching system. But since most people hook up to EIES for only a few minutes a day, the monthly cost doesn't run up.

In theory, an EIES system could cost as little as 37 cents an hour using existing equipment and telephone lines, if thousands of people wanted a similar system. Although no one expects EIES interactive networks to have a million people hooked up by 1982, the system does have enormous possibilities. Turoff says that a group of 5,000 stamp collectors, coin collectors, antique buffs, or any other group of hobbyists could start its own EIES network and operate it for a few dollars each per month. But first, experts think that lawyers, doctors, scientists, researchers, writers, government officials, and other professionals will be the first to share EIES.

DIGICAST: A Novel Approach to the Information Explosion

A third alternative—which has begun limited commercial operation—transmits digital information over FM radio waves that you can't hear. Wireless Digital Corporation of Woodside, California, developed the DIGICAST sys-

tem around the home computer instead of a regular TV set.

To pick up DIGICAST broadcasts, you must have an FM device, much like an FM radio, which receives a second signal from an FM radio station in addition to the regular radio signal that you hear on your radio. But the key to DIGICAST lies in the enormous amount of information it can transmit and receive. Teletext can send only about 300 pages at a time, or 96,000 letters and numbers (called characters); DIGICAST can send at least 10 million characters a day, or 100 times as much information as Teletext, and it requires only a small minicomputer and inexpensive extra equipment at the radio station transmitter.

DIGICAST's huge capacity enables it to send information only a few people would want, making it an "electronic specialty magazine" with an important twist: you can talk back to it. At home, you could instruct your home computer to pick up only the information you wanted and store it so that you could read it at will. And, in turn, you can transmit, as computerized data, any information you want to.

Wireless Digital Corporation conducted field trials and in 1979 proved that DIGICAST works, and in 1980 began a limited, experimental service near San Francisco. Its president, Jim Warren, Jr., wants to have 10 to 20 DIGICAST broadcasts going within a few years. Imagine the potential: more than 4,000 FM

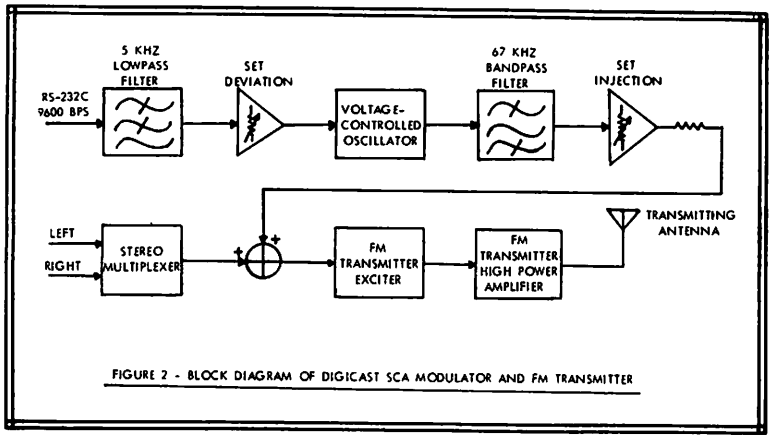


FIGURE 2 - BLOCK DIAGRAM OF DIGICAST SCA MODULATOR AND FM TRANSMITTER

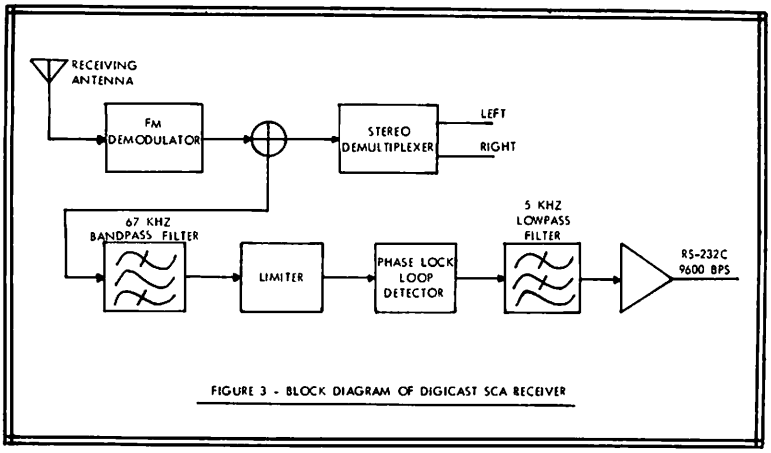
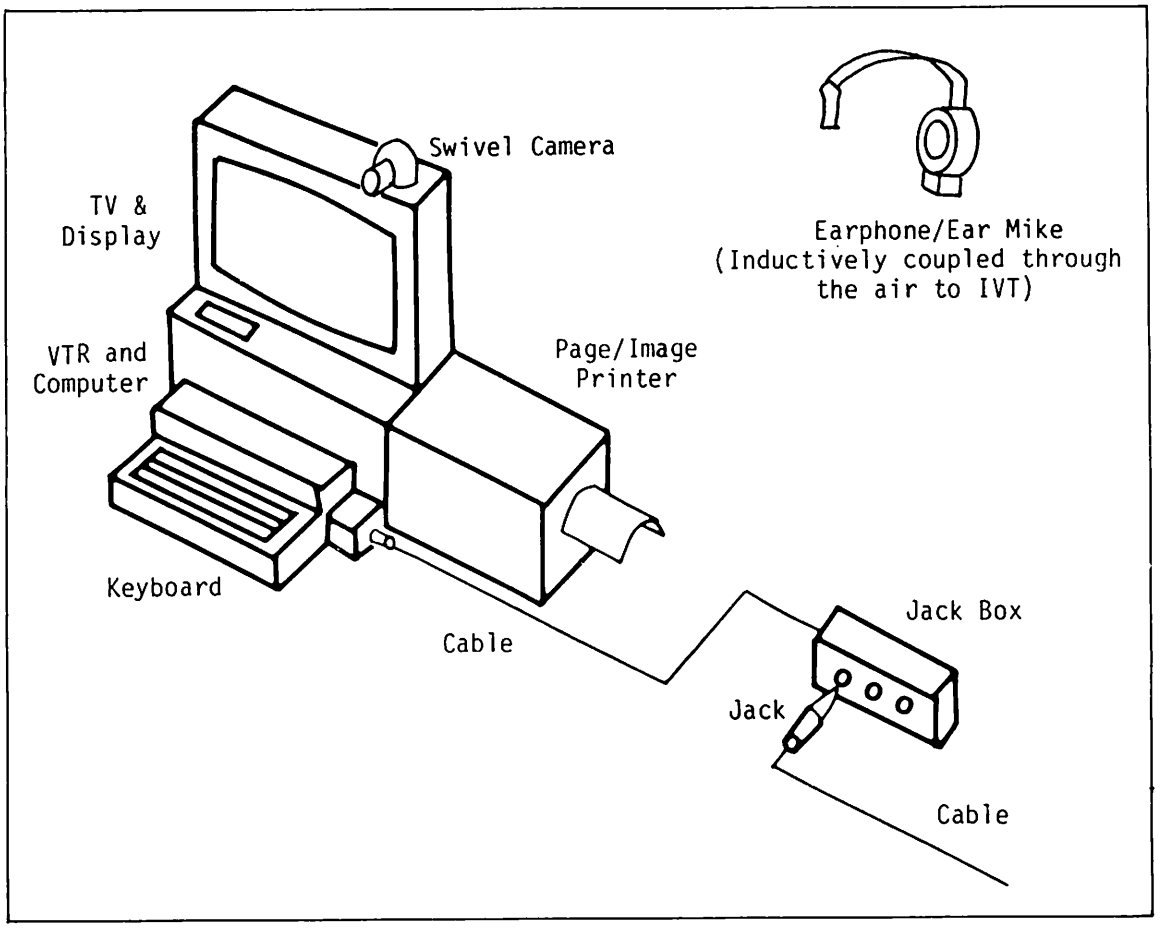


FIGURE 3 - BLOCK DIAGRAM OF DIGICAST SCA RECEIVER

Digicast transmitter and receiver block diagrams. The figure above shows how the Digicast signals will be broadcast through the FM radio signals on part of a stereo frequency. The figure below shows how the transmitted signal will be received, split off from the regular FM radio broadcast, and sent through a standard computer RS-232 interface. In the interface, the radio signals will be translated into digital messages a computer can understand. (Courtesy of Intelligent Machines Journal)



Rough block diagram of how an integrated video terminal (IVT) may appear and the features it will include. RCA, Zenith, and several Japanese electronics manufacturers are said to be preparing the IVTs for commercial introduction within two years. (Courtesy of International Resource Development, Inc.)

radio stations could establish their own DIGICAST systems, so that everyone with a home computer and an inexpensive transceiver could hook up to it.

But DIGICAST shares a problem with all of these home information services: the "chicken and egg" question. No one will build the new equipment until a working system exists, and no one will start a system until all the necessary equipment exists. Home computers, terminals, keypads, and all the means to establish these information systems now line factory shelves. All their manufacturers are waiting for one thing to happen—for the American public to simply say, "We want it."

Would you want a $1,000 machine that combines a television, a videodisk or videocassette recorder, a cassette tape, a printer, a telephone modem, and a home computer? The International Research and Development Institute, New Canaan, Connecticut, has said that at least several companies now have under development such systems—called integrated video terminals, or IVTs—in their top secret laboratories. And technically, nothing prevents any computer, television, or electronics manufac-

turer from selling such a system for about $1,000. Watch for announcements of these IVTs by 1982. You will probably own one by 1985.

You could then receive the SOURCE, MicroNET, Teletext, Viewdata (through the phone or cable television), DIGICAST, EIES, or any other home information service at the touch of a button. You—and practically everyone else—would jump at the chance to own such a system.

From Home Computers to IVTs

You may have to be patient to buy an IVT off the shelf, but you can create your own IVT system for less than $2,000. A home computer unlocks the combination that makes your own home information and integrated video terminal possible.

Between 300,000 and 500,000 families already own home computers. Radio Shack sells more than 10,000 of its TRS-80 home computers each month, and the most conservative predictions state that half of all homes will have a home computer by 1995.

As the number of owners grows, people will want to do more with their computers than play games, file menus, and keep track of how many screws they have in their workshops. When they realize they can communicate with the world—or the girl next door—for a few dollars a month, they will quickly add equipment to their computer to create an IVT, or "buy up," trading in their computer for a fancier model with all of the peripherals.

An even more important difference will happen in 1981 and 1982. The Japanese have plans to introduce inexpensive home computers in the United States. At least five companies, including Sharp, Hitachi, and Toshiba, are selling home computers in Japan, but won't market these models here because they cost too much—over $2,000. The Japanese seem to be waiting for a real mass market to grow in the United States before attacking the U.S. market with their awesome pricing and marketing techniques. The Japanese have the best technology in video disks, terminals, televisions, and computers to market an IVT before anyone else.

The Japanese also lead in what many consider the most important step to make computers a true everyday appliance: voice recognition. Many Japanese companies have developed televisions, door and car locks, calculators, clocks, audio cassettes, audio record turntables, and videocassette recorders that have no buttons; you simply talk to them and they do what you tell them—"Start," "Turn to Channel 5"—and they talk back (through speech synthesis) to you, repeating your instructions. These products should be for sale by 1982. And if the Japanese are selling talking TVs, can home computers be far behind? No, because a "listening" and "talking" home computer would, I believe, create a public demand.

Completing the Circle

When I think of all the fantastic ways to use a home computer that are just waiting for you to recognize them, I believe I have answered my friend's question, "Home computers? What good are they?" I will explore hundreds of other ways to answer that question in the rest of this book. We'll see how home computers and home information systems were first developed; we'll examine in detail all the home computers now on the market; we'll discuss how to operate them; we'll see how to use all the existing home information services and find out when the experimental ones will offer public service; we'll examine ninety-nine things to do with a home computer, including educating your children, running your business, and helping handicapped persons; and we'll peer into a crystal ball and predict how, in 1995, we'll wonder how we ever lived the way we do without our home computer.

2. What Is a Home Computer?

SINCE 1972, THE PUBLIC has slowly but surely made friends with the computer. We first got acquainted with pocket calculators. The first ones introduced in the early seventies were bulky and could only add, subtract, multiply, and divide. But calculators were rapidly taught to perform dozens of scientific and financial functions, they were added to watches and clocks, and they became smaller and smaller and thinner and thinner. Today, more than 70 million people own or use pocket calculators, and even schoolchildren would not try to do their math homework or a husband or wife pay the family's monthly bills without the help of an inexpensive calculator. No one thinks of a pocket calculator as something forbidding or uncontrollable. On the contrary, calculators speed things up, allowing bookkeepers to complete more accurate figures and businessmen to study more thoroughly the financial health of their businesses. Advanced calculators such as the programmable ones made by Texas Instruments, Hewlett-Packard, Sinclair Radionics, Commodore, and Unisonic make everyone a mathematical wizard.

A programmable calculator is simply one that you can instruct—that is, program—to perform calculations. These calculations can be as simple as doing percentages or as complicated as navigating a sailboat by the stars. Both Texas Instruments and Hewlett-Packard free you from instructing the calculator yourself; they offer preprogrammed magnetic strips and modules. Each module (those made by Texas Instruments are called Solid State Modules®) comes with 20 to 25 different sets of instructions, or *programs,* inside. To use a program in the calculator, you just slip the module into the back of the calculator and follow the easy instructions. You usually press two numbers to indicate the program you want to use and then enter your figures.

You can also write your own programs using a programmable calculator and permanently store them on the magnetic strips, called *magnetic cards* or *program cards* by Hewlett-Packard. The thin strip is made of plastic coated with a thin magnet on one side. You can store your instructions on a card because the calculator very rapidly "prints" them with a magnetic footprint after you slip a card into the card reader slot. The calculator prints the instructions, or *program steps,* in magnetic pulses rather than printed numbers or letters. And the program will remain stored on that magnetic card as long as you protect it. (Rubbing a magnet over it or exposing it to a spark of electricity would, of course, destroy it.)

Now that you know just this much about pocket calculators, you already understand the basics of a home computer. In fact, a computer is nothing more—and nothing less—than a machine that performs calculations. The only substantial difference between the calculations of a home computer and a pocket calculator, or even the math you do with a pencil and paper, is speed and sophistication.

A home computer—or any computer—can perform thousands, even millions, of calculations in one second. A sophisticated pocket calculator can do hundreds of calculations a second, and whether you realize it or not, your

brain does more calculations faster than either a computer or a calculator. But your brain would rather do other, more pleasurable things, like use your eyes to see a beautiful portrait, your hands to hold a newborn baby, or your voice to sing a song.

Your brain neither wants nor is trained to do thousands of mathematical formulas practically instantly, but a computer is. Yet regardless of how fast a computer operates, or how large its "brain" and memory become, no serious scientist ever expects a computer to be as smart as you were the day you were born. Scientists could build a computer right now that could remember as much as one human brain. According to physicist Robert Jastrow, it would take up as much space as the 102-story Empire State Building, consume one billion watts of electricity, and cost more than $10 billion to build. And Jastrow says it would still not be anything like a human brain; it would be a clumsy imitation at best. A computer will never be able to hold a sunset in awe or fall in love, despite what science fiction movies have been frightening us with for years.

In fact, any computer, no matter how large or how small, is an idiot. It's dumb, stupid, inert until you tell it what to do, or program it just like a pocket calculator. A computer is simply a machine that can do hundreds of things for you. Unlike your coffee pot or your washing machine, however, a computer is a general purpose machine, and a very versatile one at that. You might call it a jack-of-all-trades and master-of-none. It's a master only through your direction. But because it's so versatile, a computer is not just another gadget; it's a mind appliance. Just as a simple calculator now speeds up writing checks and balancing your checkbook, your home computer will increase by many times the speed and efficiency with which you plan your household budget. In fact, if you're like many people, a home computer will enable you to prepare a household budget for the first time. Doing a budget and keeping track of it every month can be drudgery, especially if you'd

The Texas Instruments TI-57 programmable calculator, one of the first programmables ever introduced, seems simple compared to more advanced calculators and home computers. (Courtesy of Texas Instruments, Inc.)

rather be working in your shop or sewing a new dress. But with an inexpensive home budget management program (dozens are on the market now), you simply enter numbers into a few columns and let the computer do the work for you.

Maybe you hate to walk around the house late at night locking doors and turning lights off. Today, for just a few hundred dollars, you can buy a system that lets your home computer do all of that—and turn on a home security system—for you. You can either operate it from your bed or program your computer to run it by itself.

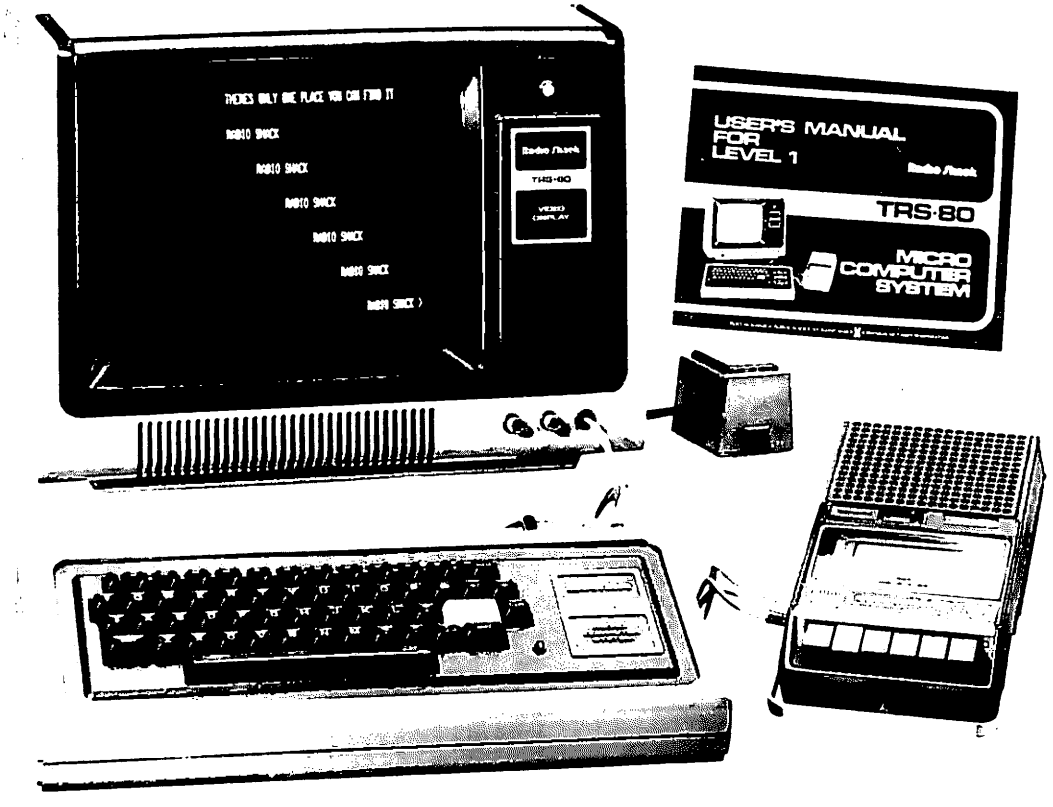
In short, your own computer can be, if not a friend, a useful servant. I don't think many people want their computers to be their "friends" like their next-door neighbor or even

their dog. But lots of us want mechanical servants that make our lives more fun, fulfilling, and satisfying. A home computer can do just that when you use it as a home administration center, a home information service, or a home information utility. Within a few years—or right now, in some parts of the country—you can connect a home computer to your bank, your grocery store, your newspaper, your favorite magazine, and your business, all at the same time for a price you can afford. In the past, machines have freed our muscles from unpleasant labors; in the present, home computers free us of mental drudgery; in the future, home computers will free our minds, direct our machines, and much more.

Familiarity Breeds Success

A home computer is made up of elements with which we're already well acquainted, although we don't call them by these names: input and output devices, such as a video monitor and a keyboard; a mass storage device, such as a cassette tape recorder; a microprocessor; and memory.

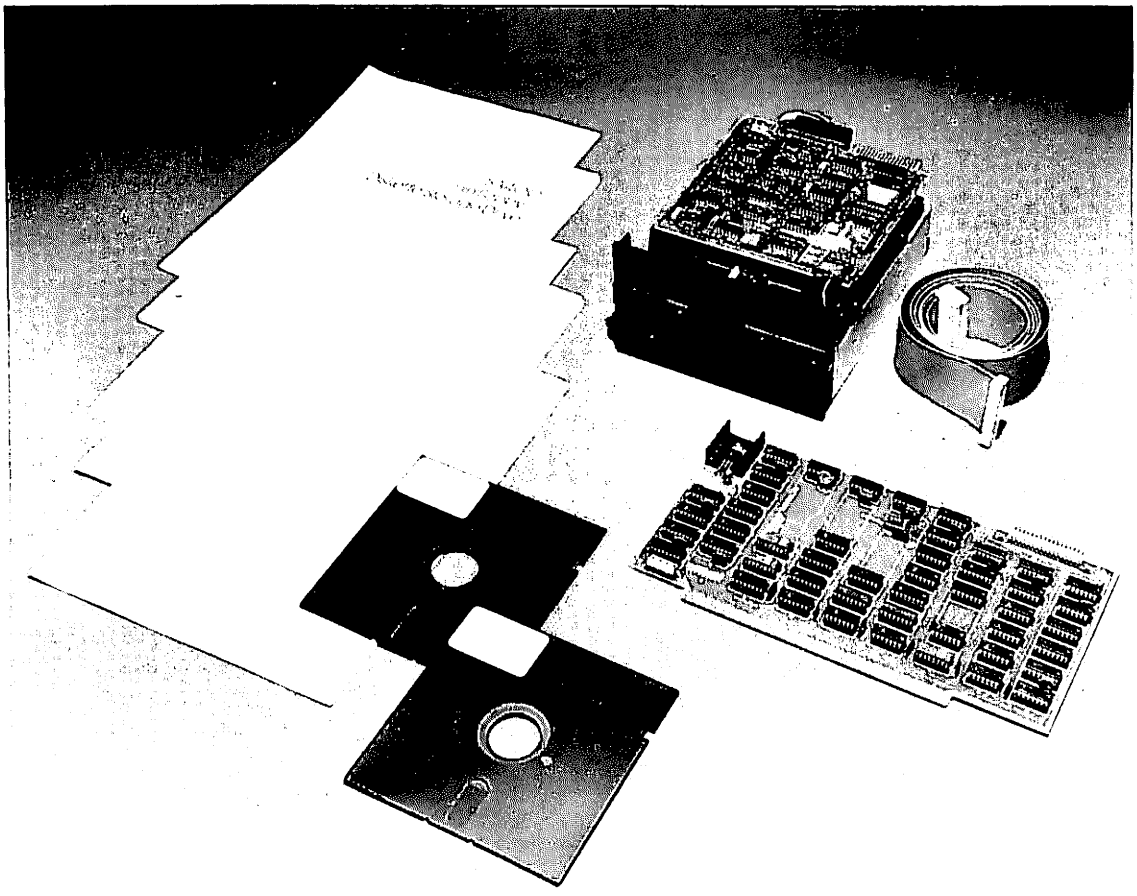
The Radio Shack TRS-80 Level I shows each basic component of a home computer system. At the top is a video display monitor, an output device; in front of it, a keyboard, an input device; beside the keyboard, an audio cassette recorder, which functions as a mass storage device; and inside the keyboard, a Z-80 microcomputer, made by Zilog, Inc. (Courtesy of Radio Shack, Inc.)



You probably know how to use a typewriter; most home computers have typewriterlike keyboards through which you tell the computer what to do, or interact with them. Telling the computer what to do is called *input,* and a typewriter keyboard is called an *input device.*

You also know what a television set is. The most common *output* device for a home computer is your home television set, linked to the computer through a radio frequency (RF) modulator. Other televisionlike output devices are called CRTs (cathode ray tubes) and video screens or monitors. The most popular monitors have color pictures, while the least expensive and less popular have only black and white. In fact, if you don't want to hook up your home computer to your television (to avoid family arguments when you want to watch the Super Bowl while your daughter wants to play Star Wars), you can buy a black and white video monitor very inexpensively.

The third essential element is a *mass storage device.* You probably own a small cassette tape recorder and a few blank cassette tapes. If you



The North Star Horizon SA400 Mini-Floppy Diskette Storage Drive is in the background; the required circuit board and connecting cable is on the right; two mini-floppy disks are in the foreground; and manuals and documentation are to the left. (Courtesy of North Star Computers, Inc.)

do, you already have a home computer's basic mass storage device. An inexpensive cassette tape is the easiest way to store sets of instructions—programs—and information outside of your home computer.

Most home computers do not have enough memory to store all the programs and information—also called *data*—you want to keep. And most home computers lose their memory and all the information you have so diligently fed them when you turn them off. So you must preserve the information outside the computer. Just as you can save pocket calculator instructions on a magnetic strip, you can save home computer information on a cassette tape.

When you send data to a cassette tape from a home computer, you change electronic pulses inside the computer into audio signals that the cassette tape can "understand." Computerized data actually change into audio signals. But if you played the tape, you wouldn't hear anything, because the signals are not in a form that the human ear can interpret. But a home computer's "brain" can interpret them.

There are at least three other popular kinds of mass storage devices. After cassette tapes, the most popular are *disks,* much like phonograph records. They are round and plastic and are imprinted with tracks that store magnetic data. Disks for home computers come in three basic sizes: 5¼ inches, 8 inches, and 11 inches. The first two come in soft plastic and are called mini-floppy and floppy disks. The 8-inch and 11-inch disks come in hard plastic and are called hard disks. In 1980, a Japanese company introduced a mini-mini-floppy, less than 4 inches in diameter.

Disks store from about 70,000 to a million pieces of computer data, called *bytes.* (We'll explain what a bit is a little later.) An average home computer can store 8,000 to 64,000 bytes of information. A cassette tape can hold as much information as a disk. But a cassette tape loads programs and information into a computer very slowly, compared to disks.

A cassette tape runs 1⅞ inches per second and can store (also called *read*) or load (also called *write*) 300 bits of information per second. Bits per second is also called *baud,* so when you hear someone say a storage device reads at 300 baud, you'll know he is discussing how fast a home computer can send or receive information—300 bits per second.

But a disk can read and write computer bits at speeds up to 9,600 baud, 32 times faster than a cassette tape recorder. Disks also use *random access* to read or write information. Using your keyboard, you can tell your computer which program you want to call off the disk, and the computer will instruct the disk reader to read that particular program regardless of its location on the disk. It could be the first program or the fiftieth, and the computer will, through your signals, call it up immediately.

On the other hand, a cassette tape recorder can't do this. To get to program 50, you have to load all 49 other programs into the computer. This could take several minutes or longer. A random access disk does it all in seconds.

But most people will use a cassette tape recorder because it's inexpensive (a $30 recorder will do well), and new cassettes cost as little as $1 each. Mini-floppy disk readers start at about $395 and each disk costs about $6.

Some home computer manufacturers use special cartridges, or in the case of Texas Instruments, Solid State Modules®—the more sophisticated brother of the modules for the TI programmable 59 calculator. These cartridges are another form of magnetic medium for storing and loading programs and data. Each one is different and can not be used interchangeably with any other machine—at least not yet. In fact, manufacturers, such as Texas Instruments and Mattel, do not want you to be able to exchange their programs easily. Their business plans call for making their profit margins on the sales of $19.95 to $79.95 cartridges.

But the cartridges do have advantages. They load very easily within seconds and they require fewer instructions in using them than either the cassettes or the disks. And the cartridge-based

Example of Texas Instruments' 99/4 Home Computer and how a user inserts a Solid State Software® command module. (Courtesy of Texas Instruments)

computers have program readers inside the computer console.

The fourth essential element in a home computer is its *memory.* Obviously, a mass storage device is one kind of computer memory because it records and stores, in a permanent form, programs and information. But computers have another, more important kind of memory within the computer itself. This memory dictates the computing or "mental" capacity of each type of home computer. There are many kinds and configurations of computer memory.

The internal computer memory can not function without the fifth essential element, the computer "brain," called a *microprocessor.* The microprocessor—or MPU, as it's known in computer language—is simply an electronic device that receives information from the outside world, performs calculations upon it, and sends out results. The microprocessor, made of three basic parts—a Central Processing Unit or CPU, input/output ports, and memory—performs the calculations for the computer and makes sure that information is received, processed, and returned in its proper order. To complete a home computer, you need only add a power supply—regular home electric current—and a clock, usually a tiny quartz clock, inside the microprocessor.

All these elements, most of them familiar electronic objects, combine to form a home computer. The combination of elements, with the unique capability of the microprocessor, creates computer power you can easily learn about and use at home.

Comparing a computer to a human body is an easy way to understand how the home computer is built. The microprocessor is the brain; the computer memory is like our brain's memory; the power supply is the heart pumping electronic signals, or "blood"; the input device is like our feet, hands, eyes, nose, and ears through which we feel, touch, see, smell, and hear the world. The output device is like our voice through which we speak to the world.

When we use our hands to type or paint, they, too, become output devices. What they produce—letters or pictures—are like mass storage, which could, of course, be returned to the computer. The console or cabinet in which the computer sits and the television set or video monitor are like our legs, upper torsos and skulls. Although the individual parts may be interesting and useful in their own limited way, it's the way all the parts combine that makes a human or a computer a fascinating and wonderful creation.

Home Computer, Personal Computer, or Microcomputer?

As your interest in home computers grows, you'll soon read and hear the terms *personal computer* and *microcomputers.* And many computer owners fiercely debate which is the correct term for this new machine. In one sense, all are correct and the three names are interchangeable: a home computer is a personal computer is a microcomputer. But in this book we'll differentiate the terms for the sake of clarity.

A home computer very properly is predominantly used at home by the whole family for entertainment, home money management, household appliance control, an information utility, a home business, home administration, or any other use that occurs through the home and family.

A personal computer, on the other hand, is used mainly by one individual for sophisticated computing and hobby applications, such as machine language programming, kit building, and esoteric or unique applications. A personal computer can be used as a home computer and vice versa. What distinguishes them is how an owner or family uses them.

The term *microcomputer* has a definite, technical meaning. According to Dr. Rodney Zaks, a noted microcomputer pioneer, a microcomputer is a computer whose central processing unit (CPU) works from a microprocessor. The CPU and the MPU are self-contained.

In its simplest form, a microcomputer has its basic building blocks on a single microprocessor. Here lies the difference between a computer and a calculator; a calculator has *no* central processing unit or microprocessor. So within every home or personal computer there is a microcomputer.

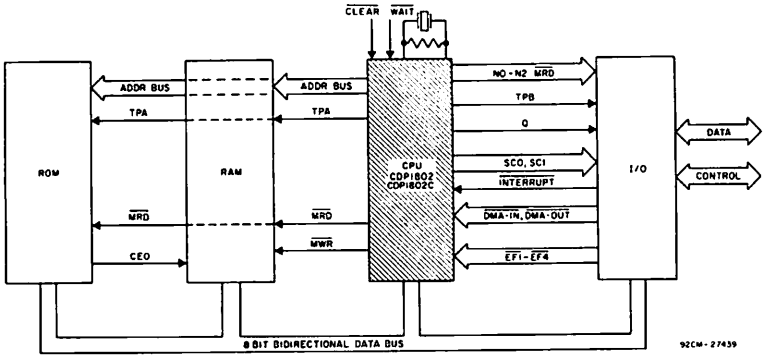


Fig. 1 – Typical CDP1802 microprocessor system.

A block diagram of the RCA COSMAC CDP1802 microprocessor system, showing the central processing unit, memory, input/output interfaces, and the bus control. (Courtesy of RCA COSMAC and Solid State Electronics Division)

Bell Laboratories scientists discovered that some substances, particularly modified silicon, are semiconductors—that is, they can either conduct electricity or insulate, or even raise or lower the flow of electricity, depending on temperatures, pressures, and methods of construction.

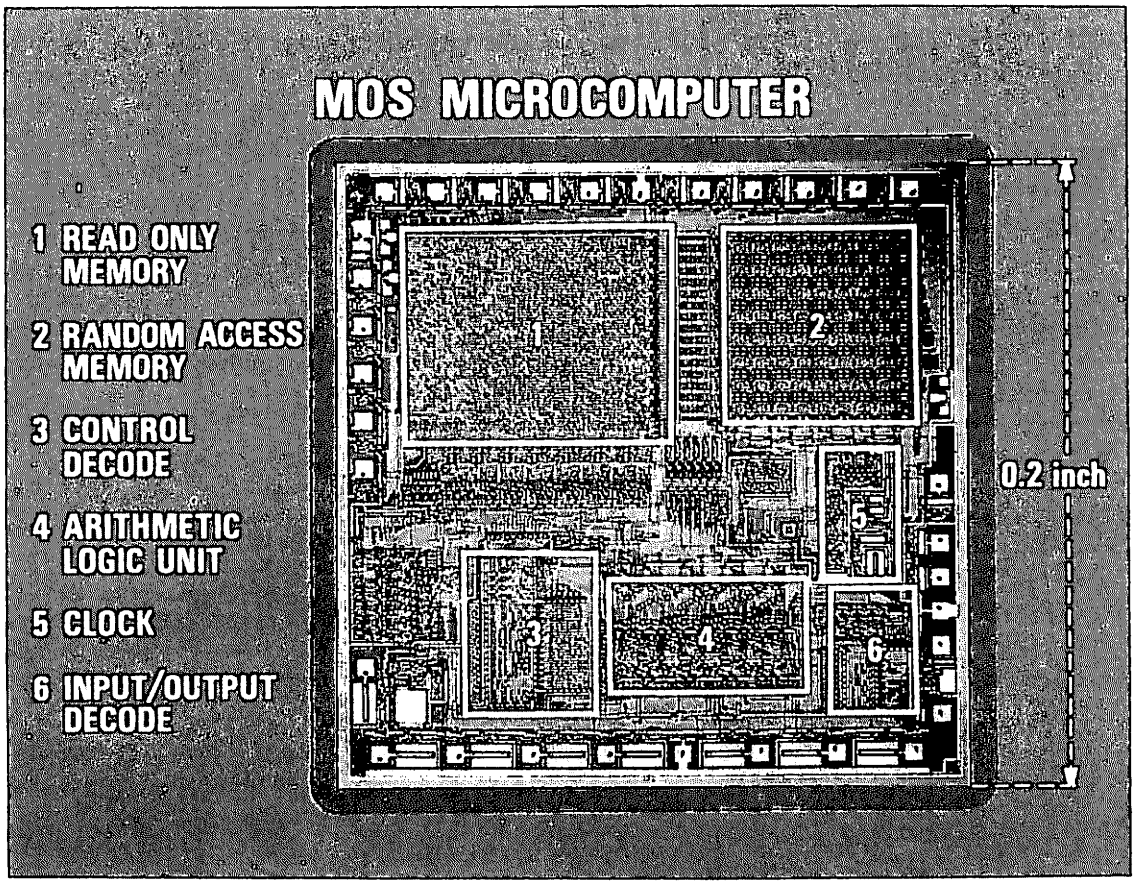
The scientists called the semiconducting materials *transistors,* combining "transfer" and "resistor." They could make transistors very small, and of the first transistors, 200 could fit inside the old radio and television tubes, called vacuum tubes. (They're called vacuum tubes because the flow of electricity occurs in a vacuum.)

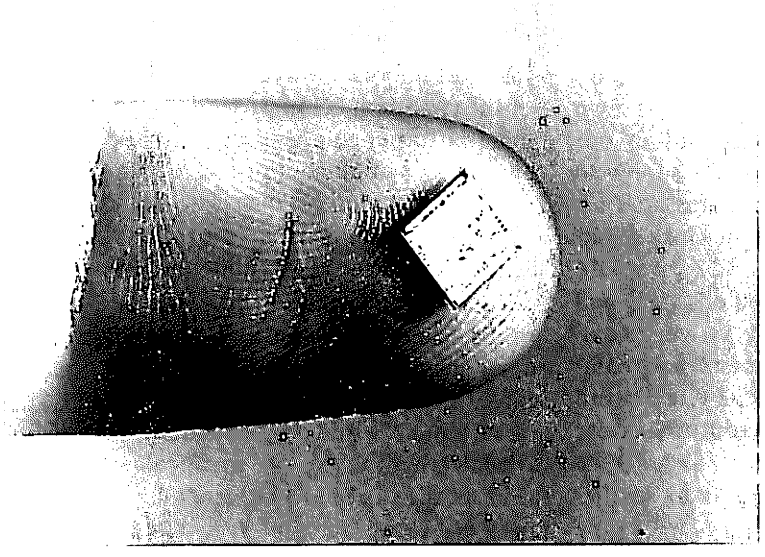
Semiconductor transistors are called *solid-state* because electricity flows through the semiconductor material, not across a vacuum.

Solid-state transistors have had an incredible impact. You've known about transistor radios since the late 1950s. Your television has been a solid-state one since the 1960s. In the early 1970s, watchmakers crammed 2,000 transistors inside a watch face and produced the first digital watches. The first electronic calculator had more than 6,000 transistors, the first electronic game more than 4,000, and so on.

As marvelous as these devices are, they are

A Texas Instruments microcomputer-on-a-chip of silicon. MOS is an acronym for "metallic oxide semiconductor." The legend identifies each part of the microcomputer, which is 2/10 inch square. (Courtesy of Texas Instruments, Inc.)





The Texas Instruments microcomputer seen in the preceding illustration is shown here in its actual size as it rests on a person's fingertip. Thousands of infinitesimal transistors are crammed onto this simple computer-on-a-chip. (Courtesy of Texas Instruments, Inc.)

not computers. During this development, engineers were also using solid-state transistors to make computers smaller, faster, and more powerful. But the computer industry and computer users wanted smaller and more powerful computers. So, during years of effort, engineers found a way to produce thousands of transistors using the wafers of silicon.

To produce a semiconducting microprocessor with a wafer requires many sophisticated technical processes. Silicon is first purified in a hot furnace. Then, a silicon wafer is treated with certain acids, some of which create positive charges and others of which create negative ones on the wafer. This process makes the silicon electrically alive.

Putting thousands of transistors onto one wafer is called *large-scale integration,* or LSI. The first semiconductor transistors were SSI, small-scale integration. The industry rapidly developed MSI, medium-scale integration. Today, as scientists seek the million-element wafer, engineers use VLSI, very-large-scale integration.

You would need a powerful microscope to study an LSI circuit. But designing each integrated circuit and microprocessor starts with a huge drafting board, perhaps as large as an entire wall. In what looks like a highway system designed by a maniac, the engineers painstakingly plot each transistor and make each connection. And since each transistor and connection is dedicated to performing just one logical function, the designers must make absolutely sure their design is perfect.

The Microprocessor Brain

Years ago, one of my favorite science fiction movies was *Donovan's Brain,* in which a human brain was kept alive outside of the dead owner's body. The brain went berserk and took over the body of another human being, and in the end, both new body and old brain were destroyed to save mankind. Needless to say, a brain on the loose scared a lot of children and some adults.

With computer brains, however, we don't ever have to worry about their getting loose. Yet you can roughly compare the five basic parts of a microprocessor "brain" or a "microprocessor-on-a-chip" to the parts of a human brain. The five basic parts of a microprocessor, as we've noted, are: CPU, or central processing unit; input/output (I/O) ports (or electronic open-

ings); memory; clock; and power supply.

The CPU can be thought of as the central nervous system monitored by the pituitary gland. The memory corresponds to our own memories. The I/O ports correspond to our nerve endings and senses, the power supply to our digestive system and blood, veins, and arteries or circulatory system, and the clock to our internal sense of time.

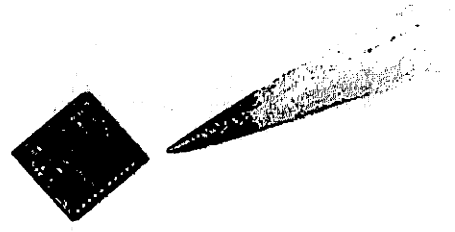
And like our brains, the computer's CPU and memory cells are contained in very, very small areas. That's why these processors and computers are called "micro," from the Greek word for small. All the parts of a microprocessor are contained on a slice or wafer of silicon—the basic building block of beach sand—smaller than a thumbnail.

Simple microprocessors have thousands of electronic elements—transistors, capacitors, and circuits—etched on a tiny wafer. And experts expect that by 1985, one microprocessor will have a million infinitesimal elements. Texas Instruments, IBM, and Bell Labs, among others, have perfected microprocessors with 128,000 elements and 256,000 elements already, although they are not yet commercially available. That million-element microprocessor will be more than 250 times smarter than the smartest electronic video game and 100 times more powerful than the most popular computer on the market now.

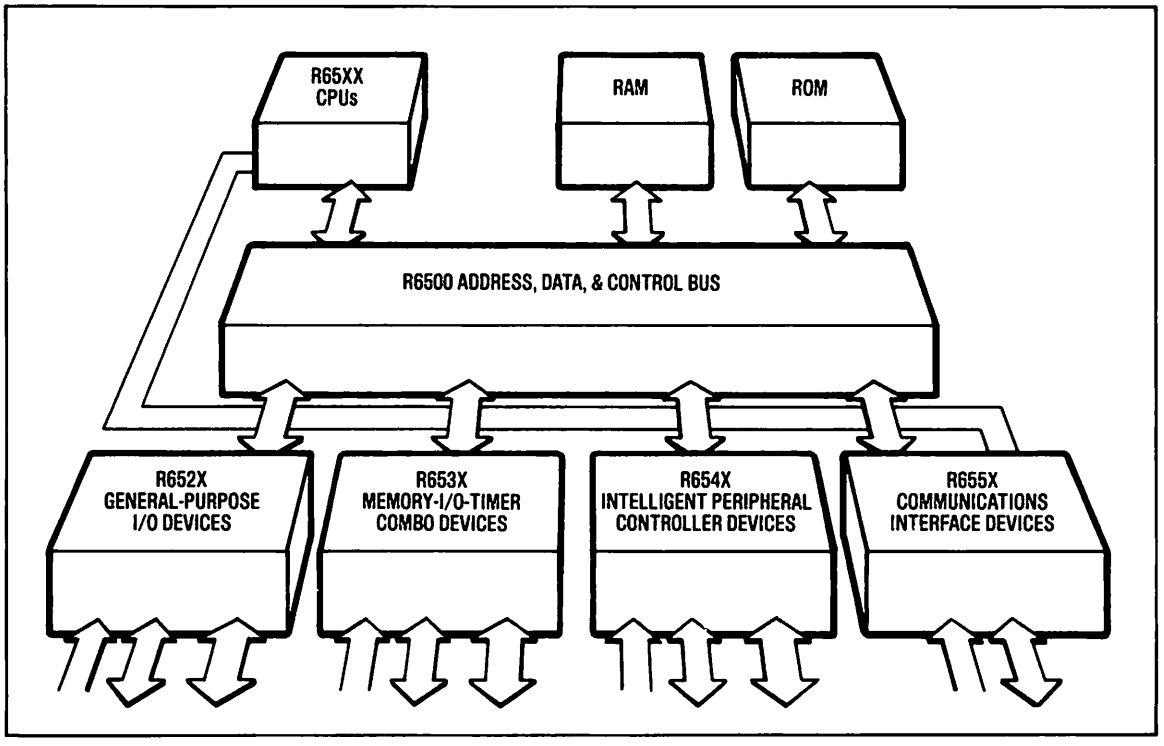
In Agatha Christie's mystery novels, her eccentric Belgian detective hero, Hercule Poirot, solved murders by using his "little gray cells." Computer brains have little gray cells, too, but they are called *integrated circuits,* or ICs. Integrated circuits, first made in the 1960s, result when a silicon wafer is connected to a ceramic or plastic shelter. The ceramic shelter acts like a skull, and tiny paths or circuits lead from the wafer—on which sits the microprocessor or microcomputer—to pins protruding out of the bottom of the ceramic piece. The pins—the wafer's nerve endings—connect I/O ports on the wafer to the outside world so that the microprocessor can send and receive information.

The microprocessor on the wafer would not be possible without what has probably become the most important invention in the second half of the twentieth century, *semiconductors.* Every material either conducts electricity or it doesn't. If it doesn't conduct, it insulates. Copper, silver, and gold are good conductors, while rubber and glass are common insulators. These materials either transfer or resist a flow of electricity.

Once they complete the design, they reduce it to the size of the wafer by a photographic process. The process uses a delicate combination of three methods. First, the design circuit is focused onto the silicon. Second, very strong ultraviolet light kicks off chemical reactions in acids in the silicon. And third, the acids etch, or in some cases, actually grow, transistors. The acids and light etch and burn transistors and capacitors across the entire wafer in a process similar to burning printing plates, in which strong light burns the shapes of letters onto an aluminum printing plate. If you visit your local small offset printer, you can see how the burning and etching process works.



Another view of how small the completed chips really are. Transistors etched onto the chip are smaller than the pencil point and can be only seen through microscopes. (Courtesy of Texas Instruments, Inc.)



The Rockwell International AIM 6500 microcomputer and its operations shown in a block diagram. The CPU communicates with memory through buses, and the bus controls the flow of information among memory, I/O devices, intelligent peripherals, and communications interfaces. (Courtesy of Rockwell International)

In the end, each wafer has tens of thousands of transistors, each a microscopic length away from the others. In fact, within the "o" in the word "transistor," you could place 5,000 transistors. And each wafer is less than ¼ inch square.

The completed wafer is called a *chip.* These chips are now made by the thousands by assembly lines of people peering through microscopes to make sure they are etched correctly. The chips are so inexpensive that a batch of flawed ones is just thrown away.

Well-made chips are then fixed to the black ceramic rectangles. The ceramic rectangles usually come with the pins already attached, so that as soon as the chip is fixed, the integrated circuit is finished. Each integrated circuit, or IC, can relay electric signals very rapidly, because the tiny pathways are so close together. Although electricity travels at the speed of light, it used to take thousandths of a second for each calculation in the first SSI integrated circuits. With LSI, calculations are performed in billionths of a second, a time so short and in an area so small as to baffle the imagination.

In 1971, Texas Instruments developed the first microcomputer-on-a-chip by placing more than 15,000 transistors with all of the elements of a computer onto an area less than 1/20 inch square. As we'll see in Chapter 3, the first practical microcomputer was developed in 1974. By the end of 1975, the race to develop the best home computer began.

Many people incorrectly use the terms "wafer" and "chip" interchangeably. The wafer is the slice of unetched silicon itself, while the

chip is the end product of the etching and burning process that puts the transistors onto the wafer. A chip becomes an integrated circuit (IC) only when the ceramic rectangle and the pin connections are attached. An integrated circuit becomes a microprocessor only when its design includes three electronic units, called registers, coder/decoders, and an arithmetic logic unit. The IC becomes a complete microprocessor with the addition of an I/O port, memory, and a clock.

Some experts and writers say that a microprocessor also has memory, input/output ports, and clocks. But it is confusing to the lay person to distinguish between a microcomputer-on-a-chip and a microprocessor. Just remember that the first microprocessors were only processors-on-a-chip and did not contain memory, an I/O port, or a clock. These elements were on different chips. Only when the first memory, I/O port, and clock were added to the early microprocessors did they become computers-on-a-chip. But the industry kept calling actual computers-on-a-chip microprocessors, and the term has stuck. So, from now on, when we refer to a specific kind of microprocessor, we also mean a computer-on-a-chip. As we've said, what most people call a microcomputer includes all the components of a home computer system, that is, CRT, keyboard, cassette tape recorder, and so on.

The Computer's Central Nervous System

If the microprocessor is the computer's brain, then its Central Processing Unit (CPU) is its central nervous system. The CPU is made of a control unit, a group of circuits which process information or data; storage registers; an arithmetic logic unit (ALU); and circuits that control the clock that makes every operation work in sequence.

The data control unit calls up—or FETCHES, in computer language—instructions called *words* from the computer's memory. The unit then figures out or interprets the instructions and follows through on the instructions, or EXECUTES them.

A *word* in computer language is simply a logical set of electronic pulses or characters, which a computer treats as a single unit. For example, the English alphabet has 26 letters, which we organize into words of different numbers of letters. English combinations or words then mean something to anyone who speaks English. The same holds true of computer words.

The CPU also has a large number of different registers. Each register holds information for the control unit and performs different tasks. The CPU moves information and instructions properly among the CPU, its individual units, I/O devices such as the keyboard and the cassette tape, and memory.

The most important of the ten different kinds of registers are the accumulator and the ALU. The accumulator does what its name implies: it accumulates each piece of electronic information before it is sent into another register for processing. Then, when one process is completed, the new information is sent back through the accumulator for rerouting. In short, the accumulator acts like the center of the nervous system.

The ALU adds and subtracts computer information in the shape of words. The ALU places each word or operation in a different register, adds or subtracts each word from another, and then puts the result into a new register. If the addition or subtraction fills up or empties a register, the result is "carried" to the next register.

The operation inside the ALU and the accumulator is the same one that occurs when you add two one-digit numbers and get a result of 10 or more. For example, we all learned in grade school that when you add 9 and 1, you put the resulting 0 in the Ones column and carry the 1 to the Tens column. That's the decimal or Base 10 system of mathematics. The way a microcomputer adds and subtracts is even simpler.

Bits and Bytes Turn into Words

The microcomputer numbering system is based on the binary or Base 2 system. There are only two numbers—1 and 0—when you count in binary. When you add in the binary system, you always add Ones to Zeroes. And instead of carrying to the Tens column, you carry to the Twos column.

For example, add 0 and 0 in the binary system. You get 0. Add 1 and 0. You get 1. But add 1 and 1. Under the decimal system, the answer would be 2, but in the binary system, the answer is 10—you carry the 1 to the Twos column.

The accompanying figure shows you how to add 2 and 2 in the binary system:

DECIMAL		4	2	1		BINARY VALUES
2	=	1	1	0	=	10
+2		+0	+1	+0		+10
4		=1	0	0		100

or 100 -------- Carry

Add 2 plus 1 in binary. The result is 011. Add 4 plus 4. The result is 1000, because you have to carry the 1 to the fourth column. And so on.

Microcomputers use the binary numbering system because electronic signals, just like any other electric signal, can exist only in two states, On or Off. When we discuss how computers operate (particularly registers) memory and information transfer, we use the binary numbers—1 and 0—to represent On and Off. A register has been switched either to On—a 1—or Off—an 0. These two states and the number symbols are also called *binary digits,* or *bits.*

As we noted above, combinations of bits are called *words.* Words are used as the standard package or bundle for transmitting electronic information. Most present home computers use, as their standard form of address, eight-bit word lengths. Eight-bit words, as an industry standard, are usually called *bytes.* But the newest home computers, like Texas Instruments' 99/4 or the Mattel Intellivision, use 16-bit or two-byte word lengths, which are two to three times as powerful and versatile as an eight-bit or one-byte word length.

The bit and byte pattern combinations determine what a microprocessor does. In actuality, all a microcomputer can really do is add and subtract, or switch bits on and off. But a computer can switch thousands of bits on and off in a few millionths of a second. Each bit and each byte is designed to have a logical function, such as to send signals or receive them from a television monitor, cassette tapes, or any other I/O device. The *word length* determines how much information a CPU can receive through I/O ports at one time. In short, a one-byte word length can send only half as much information as a two-byte word length. In the early days, the first microprocessors had four-bit word lengths, called *nibbles.* Many electronic video and handheld games still have only nibble word lengths.

Bus Stop

As you have probably realized, because of its binary language, a CPU can perform only two basic operations—FETCH and EXECUTE. In the fetch operation, information or instructions in byte form are called up and placed in a register through the ALU and the accumulator. In the execute operation, the byte is added to or subtracted from another byte and the result is then sent back through the accumulator and the ALU to an output device through a *port.*

But to get from the CPU to the output device, the signal must go through an electronic "traffic cop" called a *bus.* A bus is either a circuit or a group of circuits that make up the correct path between a CPU and an input/output (I/O) device, or a CPU and other memory.

There are two basic kinds of buses: bidirectional data buses and address buses. The latter usually controls signals between memory and I/O devices. The former, the more important, is made of eight lines or circuits on an eight-bit or

one-byte MPU, and 16 lines on a 16-bit MPU; it carries data back and forth among the CPU, memory, and I/O devices.

If the bus were not bidirectional—able to carry messages back and forth—an eight-bit MPU would require 16 lines or circuits, eight to carry information to the CPU and eight to send it out of the CPU. Without a control line, however, back-and-forth signals would run into each other on the same line; for this reason, one of the eight lines is used to tell the outside devices whether the bus is sending or receiving information.

Banks for the Memory

We've said a lot about how a home computer's memory does the same thing as our own memories—stores information. We know that our memories are made of "little gray cells." But what is a computer memory? A computer memory is nothing more than a semiconductor integrated circuit specifically designed to store large quantities of digital signals in an On or Off state.

Two basic kinds of microcomputer memory exist: RAM and ROM. RAM is *random access memory*; it allows you to "write" data words into any memory location and to "read" data words, or receive information or instructions, from any memory location. ROM is *read only memory*; it allows you only to "read" from the data words or instructions already stored inside the memory. You cannot write into or send instructions to a ROM memory.

RAM is the more versatile and the most commonly used in most home computers, because you can easily manipulate the memory—send instructions to and receive them from it. RAM is essential if you are going to use the computer for a variety of functions. When you load programs from a cassette tape or type in instructions on a keyboard, you enter them into a RAM memory. A ROM memory would neither understand nor accept any information or signals you tried to send it.

ROM is most often used to permanently store often-used sets of instructions and programs. Each home computer knows how to start operating (called *start up*) and respond to your first commands, because these "lessons" are stored in its internal ROM. And ROM is the secret of Texas Instruments' Solid State Modules.® Inside each module, a ROM chip has burned into it all the program steps it needs to run its programs. Mattel's home computer and APF's Imagination Machine® use the same principle. Hewlett-Packard's new business-oriented personal computer has the same capacity.

ROM comes in several versatile types. Standard ROM memory is *nonvolatile,* in that it is dedicated to one set of instructions, which are permanently etched and burned into the chip.

But an increasingly popular variation is called PROM, *programmable read only memory,* in which you can change the internal program with a special unit. PROM's cousin, EPROM, *erasable programmable read only memory,* can be changed or wiped out with ultraviolet light or electrical current and reprogrammed with a new pattern of bits. PROMs and EPROMs make a home computer much more sophisticated, but to use them today still requires a great deal of expertise and programming ability.

Later on in this book, we'll refer quite often to each home computer's RAM and ROM. Internal memories within a microprocessor are defined in terms of the numbers of "words" and the number of bits which make up each word address. For example, most home computers' microprocessors have word addresses which are eight bits or one "byte" long. But each microprocessor also has a memory with thousands of bits, or places for binary digits. Commonly, a home computer will have a microprocessor with a word address eight bits long, and a basic internal memory of 8,192 bits, also called 8K memory.

"K" refers to the number 1,024; 1,024 is equal to 2^{10} or 2 raised to the 10th power (2 times 2

times 2 and so on 10 times). "K" is used as a convenient computer "shorthand" to represent that figure and almost all computer operations are determined in multiples of 1,024. 2^{10} is used as a benchmark because 2 is the key number in the binary numbering system, as explained above. Therefore, 1K=1,024; 2K=2,048, 4K= 4,096; 8K=8,192 and so on.

The word address of each microprocessor represents the number of bits through which the bus sends and receives data. An "8K-by-8" microprocessor would have an internal memory with 8,192 bits operating through an eight-bit word address.

However, a note of caution is in order. The term "K" also refers to the total capacity of a home computer's ROM and RAM memory. Each one's total capacity is defined in thousands of bytes, not bits or word addresses. An 8K RAM has a capacity of 8,192 bytes or eight-bit words, or a total capacity of 65,536 bits. Be sure to distinguish between total memory capacity and a microprocessor's internal memory structure when you examine home computers. For example, a microprocessor such as a MOS Technology 6502 will have an internal memory of 8K bits and an 8-bit word address while an Apple II Plus which is controlled by the 6502 will have a total RAM memory of 16K bytes.

If you are confused by the two uses of "K," reread this description, and remember that when you are dealing with the internal structure of a microprocessor, the "K" refers to bits; when dealing with a specific computer's total memory capacity, the "K" refers to bytes. Remember, too, that it is apparent that a home computer is more powerful and versatile with more total memory and a large microprocessor.

Bubble, Bubble—Less Toil and No Trouble

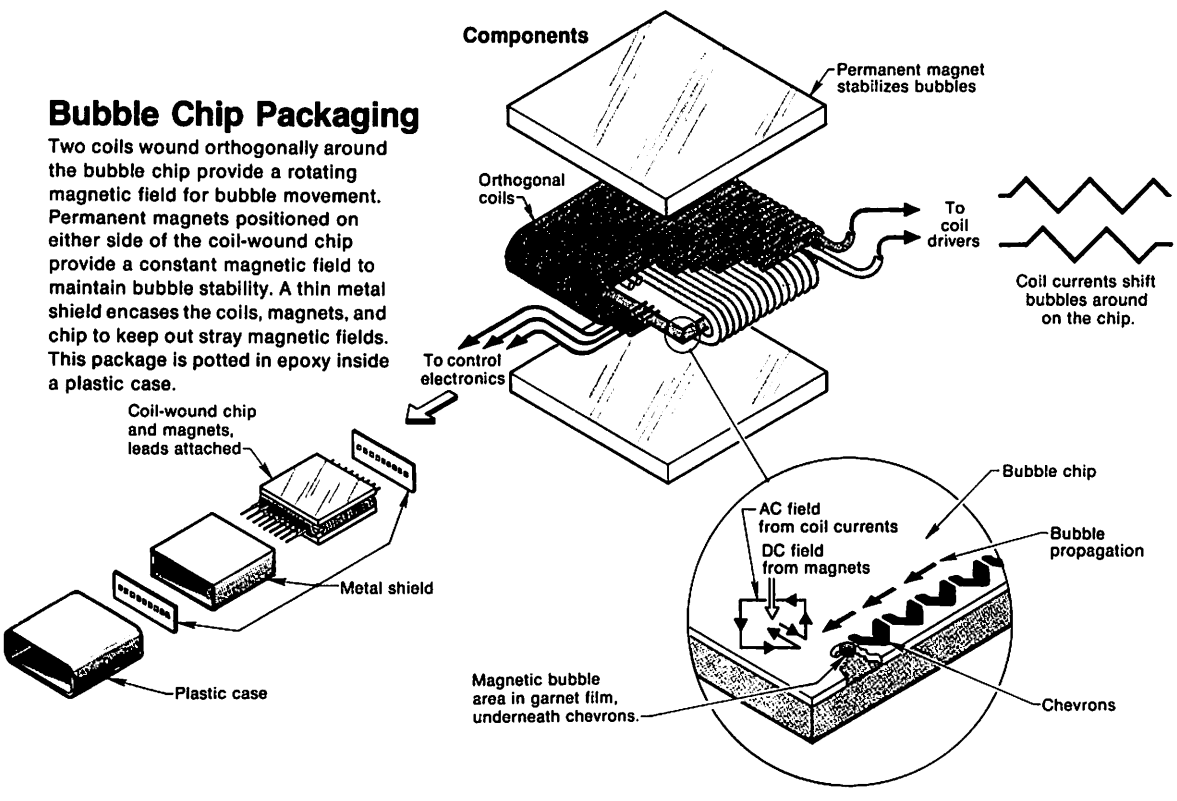
Although RAM and ROM are the most common memories today, within the next year or so, a significant change will vastly increase the memory capacity of home computers. This is called *bubble memory.* Bubble memory, though related to the semiconductor, stores bits by electromagnetism. Magnets, as you know, have two poles, a north and a south, or positive and negative. By applying an electric charge to a magnet you can change the poles and make south into north, or vice versa. If you remember what we said about bits as On or Off electrical switches, it becomes clear how bubble memories can be applied to computers. Instead of an On or Off bit, the bubble memory makes each infinitesimal magnetic bubble either a positive or a negative charge. Magnetic bubbles are incredibly small, even smaller than the smallest transistor, so that you can pack a lot more bits onto a smaller bubble memory. In fact, a 256K bubble memory for Texas Instruments' sophisticated microcomputers is in production, and the company is working on a 128K bubble memory for its 99/4 Home Computer. Other companies have announced smaller bubble memories.

The possibilities for bubble memory in home computers are endless, because it is technically easier to develop a million-bit bubble memory than a million-bit microprocessor. For example, most home computer programs used today are written with 4K and 16K bits. That includes games, household budget management, and other popular uses. But imagine how sophisticated programs can become if you can write a program using 128K bits. You could develop household control programs that monitor every electrical appliance and light in your home and your business. And so much more.

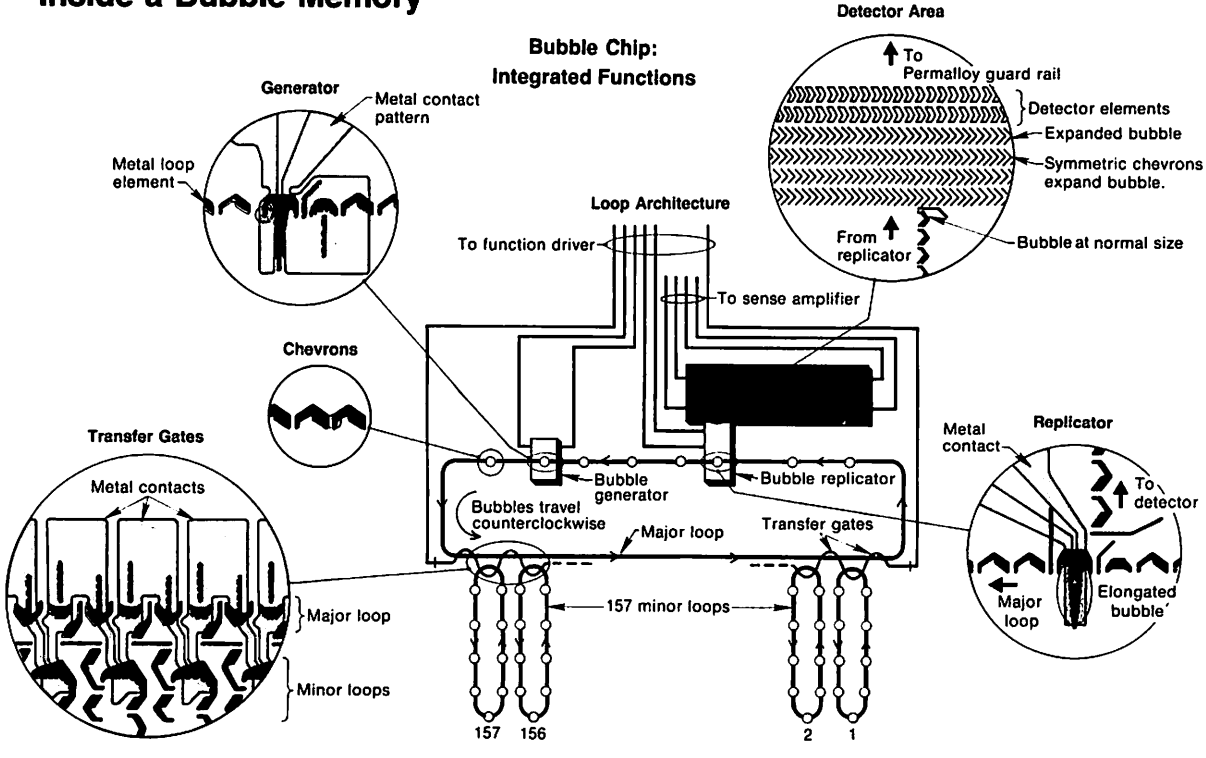
In the beginning, bubble memory will be used only to store large quantities of information, such as your last ten years' income taxes, or your last five years' monthly budgets. Bubble memory is most effective today as an inexpensive mass storage device, which is included inside the computer rather than outside like a cassette tape. And bubble memory is random access, so you can call up any information you want almost instantly.

Bubble Chip Packaging

Two coils wound orthogonally around the bubble chip provide a rotating magnetic field for bubble movement. Permanent magnets positioned on either side of the coil-wound chip provide a constant magnetic field to maintain bubble stability. A thin metal shield encases the coils, magnets, and chip to keep out stray magnetic fields. This package is potted in epoxy inside a plastic case.



Inside a Bubble Memory

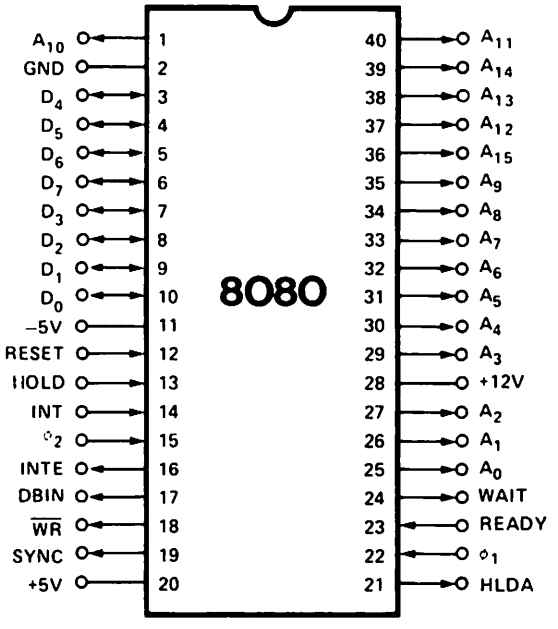


Architectural Differences

Armed with all this knowledge, however, you're still missing three important facts about home computers. First and most important, each microprocessor and CPU is different. No standard CPU yet exists, and different microprocessors are not compatible. It's clear that an eight-bit CPU and a 16-bit CPU would be compatible, but aren't all eight-bit CPUs alike?

No. The internal architecture and design of each one have been developed and manufactured with different configurations. And each microprocessor's IC also has a different number of pins, or connections, for its bus. Each microprocessor also has a unique interface, the electrical connection between the computer and the outside world. Fortunately, standard interfaces are evolving. The most common today is the RS-232 interface.

But, at present, there are at least eight popular microprocessors and three IC buses. Although a technical discussion of each microprocessor is out of our realm, the following is a list with brief description of the most popular microprocessors and buses:



The pin configuration for the Intel 8080 microprocessor, one example of the architecture of an eight-bit CPU. Others have 44 pins, 48 pins, 100 pins, or 50 pins, and each has a different arrangement for its input and output lines. (Courtesy of Heath Company)

MICROPROCESSORS

- Texas Instruments 9900 family, 16-bit word length.
- MOS Technology 6502, 8-bit word length, used in Apple, Commodore PET, and Ohio Scientific home computers
- Motorola 6800, 8-bit word length, used in Southwest Technical Products Corp.'s personal computer system
- Motorola 68000, 16-bit word length
- Zilog, Inc., Z80 and Z80A, 8-bit word length, used in Radio Shack TRS-80 and Exidy Sorcerer home computers
- Zilog, Inc., Z8000, 16-bit word length
- Intel 8080, 8080A, and 8080B, 8-bit word lengths, in Compucolor II, Interact, Processor Technology SOL, and Heath Co.'s H8 home computers
- Digital Equipment's LST-11, 16-bit word length, used in Heath Company's KD11-HA home computer
- RCA 1802, 8-bit word length, used in RCA COSMAC VIP I and II home computers

Opposite page: Block diagram of Texas Instruments' bubble memory device, showing how electromagnetic shift bubbles around on the chip. (Courtesy of Texas Instruments, Inc.)

BUSES

In general, the more pins, the more input and output (I/O) devices you can plug into the computer. But it all depends on the arrangement of the CPU and the memories.

For example, the S-100 bus, a set of copper "wires" on a large printed circuit board, can accept up to 20 "plug-in" devices, such as memory and I/O ports.

These are examples of popular buses:

S-100, used as the standard bus in more than half of all home computers
S-50, used in the Compucolor II, among others
IEEE-488, used in the Commodore PET
OSI-48, used in the Ohio Scientific line
RS-40, used exclusively in the TRS-80 line

Interfaces

As we have noted, an *interface* is the actual physical connection between the microcomputer and the outside world. An interface is like the wall socket that connects electric wiring in the house to the lamp cord.

In home computers, there are three basic types: serial, parallel and analog interfaces. Parallel interfaces allow for high-speed transmission because they use all of a computer's information or data lines at once. Serial interfaces, on the other hand, change the data lines into a system that handles one bit at a time, a relatively slow process. Analog interfaces convert analog signals into digital bits, or vice versa. An analog signal determines a distance along a scale, as a car speedometer tells you how fast you're traveling by converting the spinning of the tires into a number on your speedometer. A thermometer or a weight scale is another example of an analog signal.

Back to Square One?

Tie all these elements together and you have a functioning home computer. And most of the home computer's elements you already know and use in other appliances. You use a television monitor five or six hours a day. You probably have a cassette tape recorder and a record player, so that you're familiar with mass storage devices. You probably know how to type on a typewriter. You may even use a terminal occasionally at work.

And you've read how simple the internal operation of a microcomputer really is. It merely subtracts, adds, multiplies and divides 1s and 0s in incredibly fast operations on a tiny clump of burned beach sand. Who said computers were difficult?

3. The First Generation: Chips off an Old Block

THE HUGE PASSENGER JETS that we fly today had their roots in thousands of years of human intellectual development. Long before the Wright Brothers made their minute-long flight at Kitty Hawk, inquiring scientists and inventors had probed the secrets of flight. In the early 1500s, the great Leonardo Da Vinci drew extensive plans for a flying machine and predicted the age of flight.

Before we could fly like the birds, however, we needed the knowledge to make wings that would hold up heavy weights and engines that would be powerful enough to defy gravity and air currents. The technological discoveries of many inventions came together to put the Wright Brothers in the air, but once someone combined them, technology was able to take quantum leaps forward in very short periods of time.

The same process occurred to make possible, first, any computer, and now, home computers. The Arabs developed our 0–9 numbering system in the early Middle Ages, but it wasn't until the Renaissance that Europe gradually adopted it. Then, in 1643, the mathematician Blaise Pascal (after whom a high-level computer language is named) invented an arithmetic machine that counted 0 through 9 with a series of wheels. A tab at the wheel's edge pushed or "carried" the 0 into the next column, much like pedometers or automobile odometers do today as they count up miles. Fifty-one years later, another mathematician named Leibniz changed the arithmetic machine so that it could multiply and divide.

It wasn't until 1834 that another significant change leading to computers occurred. In that year, Charles Babbidge began his "analytic engine." Babbidge operated the engine with instructions on punched cards, very similar to those used in modern keypunch operations. Babbidge also wrote and theorized about memory and output devices, but the technology was not yet available to make them.

But Babbidge, who never finished his engine, accomplished an even more important objective as far as moden computers were concerned. He was the first mathematician to try to use a machine to represent "pure" numbers instead of quantities or analogies like a thermometer reading or an odometer. And, as you know, "pure" numbers are the basis for digital counting.

During the mid-1800s, thanks to pioneers in the study of electricity, electromechanical devices were being developed—the telegraph in the 1840s, the telephone in 1876, and many more. It was in the late 1880s that they were first applied to the punched card concept. And the combination of the Babbidge engine concept and an electromechanical device saved the 1890 U.S. Census from chaos.

Herman Hollerith used an electromechanical hole puncher to represent the letters of the alphabet and the digits 0–9 on a paper card. The card had 80 columns and was rectangular in shape. In fact, it looked remarkably like the 80-column keypunch cards used today. The Hollerith 80-column code is still the modern standard.

Demonstrating the punch card machine, Hollerith won a Census Bureau contest to de-

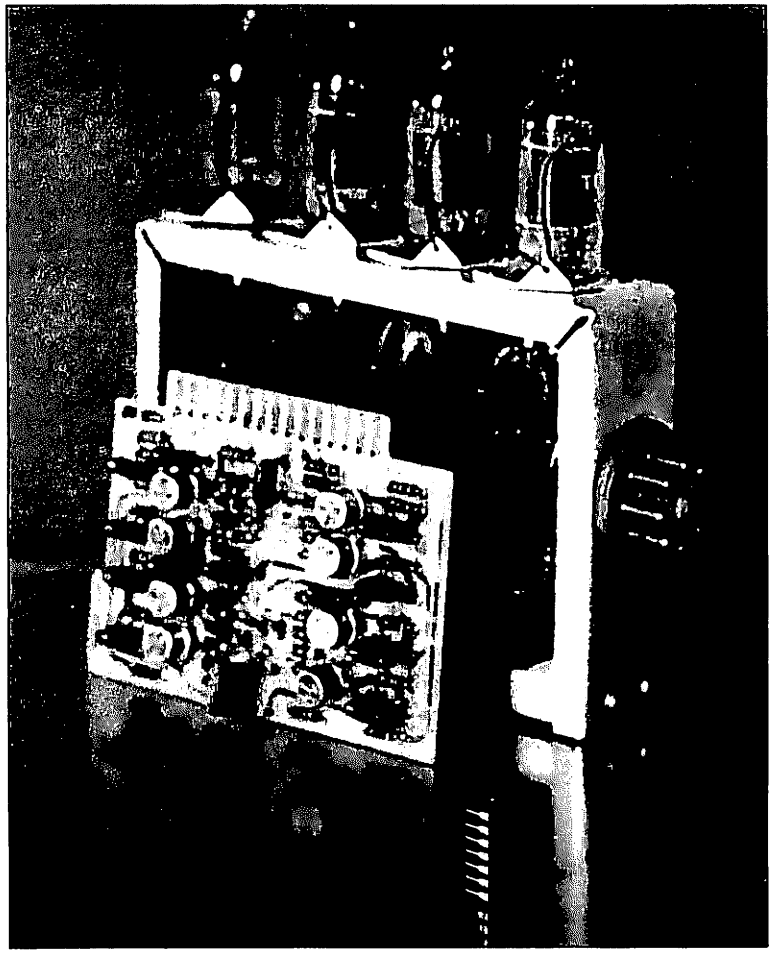
velop a faster way to complete the census. Even 90 years ago, the Census had become far too complex to complete by hand. But Hollerith's device completed the entire census more than twice as fast as it had ever been done before.

Hollerith's punch card principle is important to the history of computers because it used a basic principle of digital counting. When the device received a signal to indicate a number, it punched a hole; when it did not receive a signal, it did not punch a hole. That same idea can be applied to binary digits, as we saw in Chapter 2. And Hollerith first used paper tape to enter into and receive information from a calculating machine. Paper tape readers remained the most popular means of instructing computers in the 1950s and early 1960s.

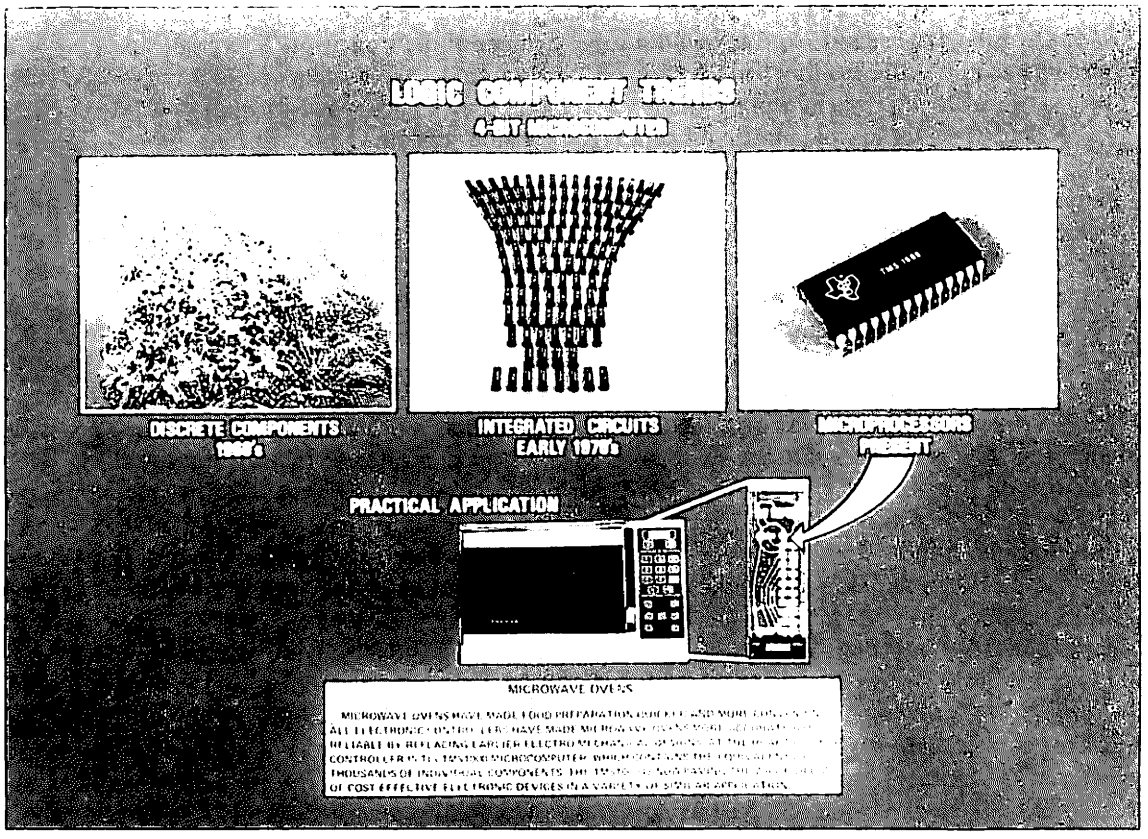
As important as Hollerith's invention was the Burroughs electromechanical adding machine introduced in 1885. By 1917, the first four-function electrical calculator was in operation.

Many refinements in electromechanical and electrical counting devices were made between 1917 and 1946, particularly for military use during the two World Wars. In fact, scientists making the atomic bomb developed the direct ancestor of the first computer, because they needed to make rapid calculations for atomic bomb equations.

In 1944, the first two computers—which



From vacuum tubes to transistors to integrated circuits. The rapid progress and miniaturization is illustrated here, but not the scope of power. While the board of solid state transistors had a little more power than the vacuum tubes, against which it rests, the integrated circuit in the foreground has more power than an entire roomful of the vacuum tube circuits. (Courtesy of Texas Instruments, Inc.)



An illustration of how microcomputers developed from transistors and discrete components first introduced in the 1960s. More than 9,700 discrete components had been fixed inside 137 integrated circuits by 1970. But by 1974, the 136 integrated circuits had been fixed inside one four-bit microcomputer, the Texas Instruments TMS 1000 family. This microcomputer today controls dozens of hand-held electronic games and home appliances, as the illustration indicates. (Courtesy of Texas Instruments, Inc.)

counted numbers and not analogies—were completed. Both were huge monstrosities filled with thousands of electrical relays. At Harvard University, Howard Aiken's MARK I weighed five tons and had more than 3,000 relays, while at Bell Laboratories, scientists used telephone-like relays to count numbers. Both were considered marvels: MARK I multiplied numbers of 12 places—such as 123456789012 times 210987654321—in less than three seconds, and the Bell Labs' computer multiplied two 10-digit numbers (1234567890 times 1234567890) in just a couple of seconds.

But the electrical current to make these calculations, though moving near the speed of light, proved too slow to be of real use, because both computers required moving mechanical parts to make their calculations. Obviously, that takes time, and even just a few thousandths of a second is slow in computer time.

In 1945, a leap forward occurred when ENIAC (Electronic Numerical Integrator and Computer) became the first computer based on vacuum tubes. Vacuum tubes make electricity flow between a filament and a plate in an open space emptied of air. Electricity can flow be-

tween the two spaces near the speed of light, 186,000 miles per second. And a vacuum tube, just like a light bulb, can be turned off or on—the basis for the digital counting system.

ENIAC was another mammoth machine: 18,000 vacuum tubes, 70,000 resistors, 10,000 capacitors, and 6,000 switches crammed into a 3,000-square-foot box. (Modern homes average about 2,500 square feet in size.) ENIAC consumed as much electricity as 14,000 average light bulbs. And it was notoriously unreliable. If one of the tubes went on the blink—which one did about every six minutes—the computer made errors. But when it was working as it was supposed to, it could mulitply two ten-digit numbers in just three thousandths of a second, almost 1,000 times faster than the first two computers could do it.

After ENIAC, its younger brother EDVAC, and a host of other "ACs," electronic computers exploded. IBM installed its first computer in 1948, introduced its first major business model in 1953, and was soon joined by Honeywell, Burroughs, and many others in the race to computerize government and business.

Parallel to the explosion of huge business and scientific computers, the groundwork for home computers was laid in work by Bell Laboratories and International Telephone and Telegraph. In the late 1950s, Bell Labs had discovered semiconductors—the substances, such as silicon and germanium, through which a flow of electricity can be controlled, that is, increased or decreased.

From this discovery, the scientists made transistors that work just like vacuum tubes, but that can be made as small as millionths of an inch in size. Operating like a vacuum tube but in an infinitesimally small space, a transistor can move electricity tens of thousands of times faster than a vacuum tube, enabling computers to do many times more calculations per second. Indeed, transistors turned the computer into an incredible device that can do in minutes calculations that would take armies of people years to complete.

You have lived through much of the development of the transistor. The first transistors were "large"—200 of them could fit into one vacuum tube. Even so, transistor radios, solid-state television circuitry, and dozens of transistorized devices proliferated through the 1960s. Of course, computer scientists also adapted transistor technology and, through integrated circuits (ICs, which we discussed in Chapter 2), developed minicomputers.

The First Microcomputer

The first computer-on-a-chip of silicon was developed by Texas Instruments in 1971. But it wasn't until 1974 that the first microcomputer as we know it today was made. Intel, a New Mexico-based company, introduced its 4004 microprocessor in 1973 and its 8008, based on eight-bit word lengths, in 1974. Although business and industry were excited by these developments, the general public knew little about them. But the 4004 quickly found its way into the first electronic video games. Atari introduced its Pong TV game in 1975, and Magnavox followed with Odyssey. The first hand-held electronic game came out in late 1976 and by Christmas 1980, hundreds of hand-held games will have been sold for as little as $10, and the volume of computer game sales had surpassed 10 million games. You can't walk into a movie theater or arcade today without bumping into children playing with modern electronic pinball games that sound like a *Star Wars* soundtrack.

The public rapidly accepted electronic games and pocket calculators, but home computers were yet to arrive. Waiting in the wings, however, thousands of computer engineers, programmers, and just plain folks wanted their own computers. Then, in late 1974, Intel introduced its 8080 microprocessor, and the January 1975 issue of an electronics magazine described the first home computer kit, the MITS Altair 8800, based on the Intel 8080. The MITS Computer Co. (which has become PERTEC) did not expect anything like what happened next. It re-

The Atari Video Computer System, the successor to the highly successful Pong video game, itself became the father of the new Atari Personal Computer System. The video system was introduced in the mid-1970s, the home computer system in 1979. (Courtesy of Atari, Inc.)

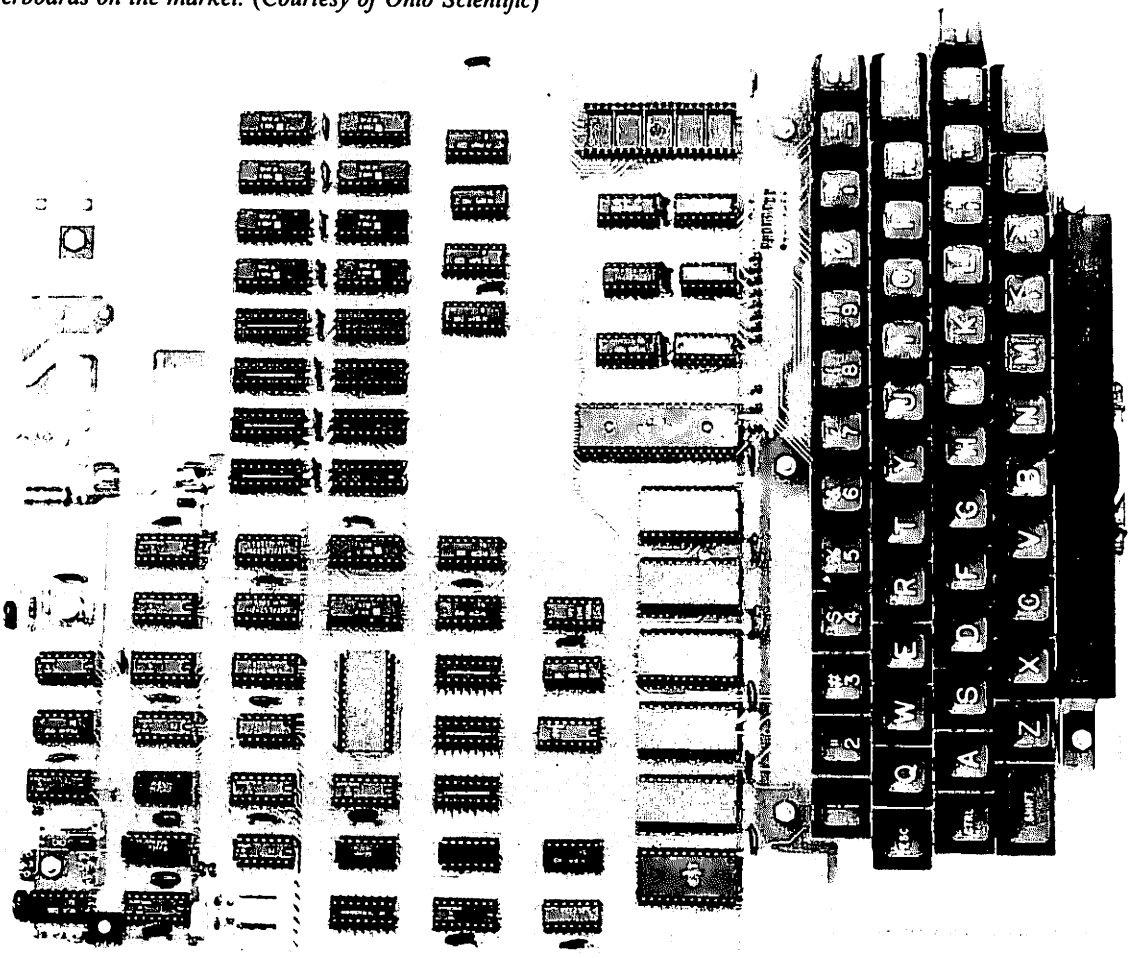
ceived thousands of inquiries and cash orders for the new microcomputer. This explosion occurred before MITS or anyone else had been able to make more than a few microcomputer kits for sale.

Computer engineers and entrepreneurs sensed a revolution, and hundreds quickly began developing and marketing different parts for microcomputers. These first computers were little more than integrated circuit memory chips, a microprocessor, and one or two interface ports on a plastic rectangle called a motherboard. And anyone who wanted the computer to run had to put the pieces together him- or herself. Still, dozens of kits were for sale by the end of 1975. To use a kit, once you got it put together correctly, you had to know how to talk to the computer in its own language. A computer's mother "tongue" is called machine language and consists of strings of digital 1s and 0s. Only

programmers, engineers, and hobbyists could work with these first computer kits.

Most of this burst of activity in personal computers centered on a piece of real estate in Northern California that for decades had been orange and grapefruit groves. Now computer engineers, with a little financial backing, set up small shops in industrial parks around this area and started designing and producing microcomputers and additional equipment, such as video screens, typewriterlike keyboards, plastic boards packed with memory chips called memory boards, printers, and other devices. All these additional devices are called *peripherals* in the language of computer hobbyists.

This new "grove" of computer companies quickly became known as "Silicon Valley." Near Palo Alto, the valley has what may be the greatest concentration of computer knowledge in the world. Even today, despite new centers of home computer development in Texas, Massachusetts, Southern California, and Long Island,



The Ohio Scientific Superboard II, a typical configuration for a microcomputer motherboard. The large integrated circuit chip just above the "7" key on the keyboard is the system's central processing unit. The other chips are memory chips, computer language chips, and other chips that help operate any microcomputer. The Superboard was one of the first motherboards on the market. (Courtesy of Ohio Scientific)

New York, Silicon Valley remains the capital of the personal computer revolution.

As MITS Co. emerged from its backlog of orders, the first computer store opened in mid-1975. Again, computer aficionados and entrepreneurs sensed a revolutionary opportunity, and within 18 months, several hundred computer stores had sprouted all over the country. The news media seized upon the dramatic change that was happening all across the country and publicized personal and microcomputers wherever the first one was sold or the first computer store in an area opened its doors. As computer expert Ted Nelson has often remarked, the first two years of personal computing were wild and crazy—and limited to those thousands of computer buffs who had longed for or wanted to learn how to build and use a computer.

A small computer company called IMSAI soon copied the Altair 8800 and marketed its own model, which, with modifications, has become a standard microcomputer in industrial and research applications. About the same time, Robert Marsh, a computer engineer, founded Processor Technology, which marketed the first computer complete with keyboard and video screen—SOL, the first personal computer deserving the name. A group of college students founded Cromemco, a shortened form of the name of their college dormitory. Cromemco now is an important manufacturer of small business microcomputers.

In early 1976, groups of microcomputer buffs began to band together in hobby computer clubs and groups to learn the basics of personal computing and share information, programs and computer parts—or hardware. Simultaneously, the first hobby computer magazines appeared. The first, *Byte,* soon gained a circulation of more than 100,000. (In 1979, publishing giant McGraw-Hill purchased *Byte* magazine and its book and program publishing operations.)

Entrepreneurs and hobbyists had begun to hold computer conferences, fairs, and festivals, beginning around the San Francisco Bay and Silicon Valley areas and rapidly spreading to major population centers such as Boston and Philadelphia. Organizers were swamped as thousands of people crammed these weekend affairs to touch, test, and play with these strange new devices.

By the end of 1977, according to the latest figures, hobbyists owned between 30,000 and 50,000 microcomputers, and betweenn 300 and 500 computer stores had opened their doors, among them several franchises, including Byte, Inc., and Computerland. Truly, something remarkable had happened around the country.

The First Home Computers

Except for the first version of the Processor Technology personal computer, called SOL, there was no complete home computer at the beginning of 1977. But 1977 proved to be a watershed year for home computers. The mainstays of the home computer market—Commodore PET (Personal Electronic Transactor), Apple, Radio Shack, TRS-80, Exidy Sorcerer, and Ohio Scientific's Challenger, to name a few—were all introduced that year.

What sets them apart from the kits, motherboards, and mainframes of the first two revolutionary years is simply this: each is a completely assembled computer with all its elements—keyboard, microprocessor, memory, I/O devices, and so on—in a neat, usable package. All of them are as easy to use as slipping a cassette cartridge into a slot. The microcomputer had become an appliance that any of us could afford and use. The days of the tinkerer were ending and the day of the computer as a mind appliance was beginning.

Here's a brief look at some of the earliest microcomputers and the first generation of the true home computer, roughly in chronological order. Many of the features of the first home computers, which remain on the market, will be discussed in greater detail in Chapter Six.

The original Commodore, Inc., PET personal computer with its calculator-style keyboard, in an all-in-one unit. (Courtesy of Commodore, Inc.)

Hobby Computers

The first wave of microcomputers appealed by necessity to the hobbyist market. The MITS Altair 8800A and 8800B, the IMSAI 8800, Cromemco's Z-1, Southwest Technical Products 6800, the Polymorphic 8800, Vector Graphics V-1, the KIM 1, and many others required extensive knowledge of basic electronics and computer programming. But thousands were sold as hobbyists or "glitch-kickers" tasted the first fruits of the microcomputer revolution.

For example, the Altair 8800 and IMSAI 8800 both have front control panels with red LEDs (light-emitting diodes) and rows of switches. To use these computers, a hobbyist had to know how to flip the switches, each of which gave the Intel 8800 microprocessor an individual instruction. Flipping switches instructs the computer in its own language, called machine language, and obviously is far too sophisticated for a layman.

But a hobbyist (or more usually, an engineer, scientist, or researcher) could attach many peripherals to these machines through their bus structures. All the 8800 hobby computers had

S-100 buses, and they could add up to 18 different devices, from a keyboard—which made programming much easier and quicker—to a video monitor, a printer, or similar device. For example, the IMSAI 8800 has become very popular for scientific uses because its layout allows an even greater number of peripherals, 22.

The Polymorphic 8800 made two important strides when it was introduced in 1976. Unlike the first modules, it came with its own connection or *interface* to a video monitor, and a connection for a cassette tape recorder as the mass storage medium. The earlier hobby computers had neither; all these connections or interfaces had to be added—at extra cost and with greater knowledge. But most important, the Poly 88, as it's known, had only two switches. Instead of depending on the operator's step-by-step instructions, the Poly 88 computer already had its basic instructions fixed in its ROM (read only memory). To use the Poly 88, a hobbyist needed only to plug in a keyboard and type in program instructions, or just plug in a cassette tape recorder and "read" in a program already stored on tape.

But operators still had to understand computer programming, and, although Polymorphic provided excellent support with an easy-to-use computer language, called BASIC, it was still basically for hobbyists, or people willing to learn the ropes.

The Apple II personal computer with two disk drives, a video monitor, a printer, and a telephone modem. (Courtesy of Apple Computer, Inc.)

The first computer a hobbyist could simply turn on and use was the Processor Technology SOL 20. It had its own keyboard, an audio cassette interface, a complete video processor that used numbers and letters (in upper and lower case, or capitals and small letters), both kinds of input/output ports (serial and parallel), and an internal power supply. It had neither switches nor blinking lights on a complicated-looking front panel. It did have an internal operating system fixed in its memory, which allowed a user to simply plug it to a video monitor and use it. (An *operating system* contains a set of instructions that "wakes up" a computer, making it ready to receive instructions. In the earlier hobby computers, the hobbyist had to do all this himself.) Yet the SOL, too, was too complicated for the average user. A buyer still had to know computer programming to use it.

Kits are for Kicks

While these developments were taking place, many novices became interested in learning home computers from the chip up, so to speak. They bought the first machines as kits and put them together themselves. Many of the first computers are still available as kits, and if you,

The basic TRS-80 Level I home computer from Radio Shack: a modular system with video display, keyboard, and mass storage recorder separate and distinct parts. (Courtesy of Radio Shack)

The Exidy Sorcerer computer, a single-board computer with a typewriterlike keyboard and number keypad. (Courtesy of Exidy, Inc.)

too, want to learn how computers work and how to talk computer language, you can still buy inexpensive, easy-to-assemble kits. The least expensive, easiest kit is the RCA COSMAC ELF II, which only costs about $100. It's based on the RCA 1802 microprocessor. All you need to know to build this easy kit is how to read and how to solder contact points. Mostly, you only have to plug things into sockets on plastic boards. Each ELF II kit comes with an RCA 1802 microprocessor, a video graphics integrated circuit, two small memory ICs, a bundle of connectors, resistors, capacitors, and socket pins. It comes with a display of 10 LEDs and a keyboard with 17 switches for a hexadecimal (base 16) numbering system.

The manufacturer, Netronics Research and Development, Ltd., of New Milford, Connecticut, provides step-by-step instructions with a clearly marked letter- and number-coded chart and wiring diagram. To see the results of your efforts, however, you'll have to add a small video monitor. Netronics offers ELF's big brother, an Explorer, a complete microcomputer system to which you can add five increasingly sophisticated levels of peripherals and memory.

The most popular home computer kits, which require more sophisticated knowledge, are Heath Co.'s H-8 and H-11 microcomputers. Both are excellent machines and will introduce you to higher levels of electronics, hobby computing, and computer languages.

Another way to learn the fundamentals of electronics and microcomputers involves evalu-

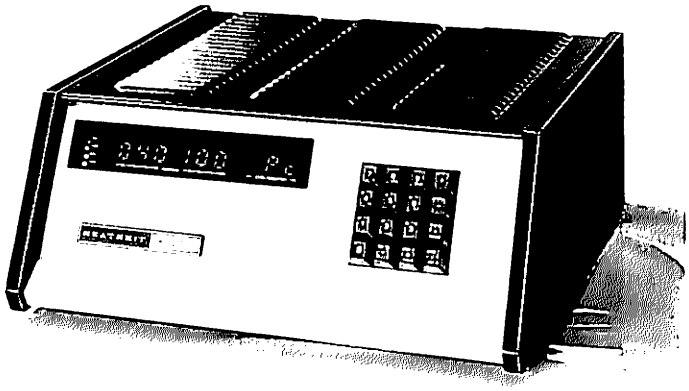
ation kits. Most often sold to colleges and high schools, these kits are fully functional microcomputers on a board. Many companies—Texas Instruments, National Semiconductor, Motorola, Signetics, Hewlett-Packard, and Rockwell International—sell these kits. Their appearances are similar; they come with a keyboard attached to what looks like a maze of integrated circuits and minute connections. Some have small printers and digital displays to show the hobbyist or student the results of his or her computations. The companies also include complete textbooks, which guide the new hobbyist through each step to learn what microprocessors are and what they do. They also include instructions in the essentials of computer language and teach communication with or programming the kit.

But even in 1977, most people wanted to buy home computers they could use like stereo outfits or portable typewriters. Although not that easy at first, the earliest true home computers took the first giant steps in that direction.

Signetics' Instructor 50 is an inexpensive microcomputer designed as a training aid for students or beginnners. It comes with a user's guide, instructions, and cassette-based programs for learning how microcomputers and programming languages work. (Courtesy of Signetics, Inc.)

The Early Home Computers

The first versions of the home computers, which remain the most popular today, were introduced by several manufacturers in 1977.



The Heath Company H-8 personal computer as it appears when fully assembled. (Courtesy of Heath Company)

TRS-80

One of the simplest—and the most successful—was the Radio Shack TRS-80, Level I, which originally sold for $599 (now usually $499) and came complete with a keyboard, video monitor and cassette tape recorder, and power supply. It uses a Z-80 microprocessor and comes with 4K RAM (random access memory).

The black and white video monitor has a 12-inch diagonal screen and shows 16 horizontal lines of text and 64 vertical characters, for a total of 1,024 characters. The keyboard has 53 standard typewriterlike characters and computer commands. The TRS-80 Level I has its own operating system in BASIC language and works as a very powerful small computer. You could expand the first model to up to 16K of RAM, and Radio Shack quickly made available more memory and many useful peripherals, including a floppy disk mass storage device, several different printers, a telephone modem, and many more peripherals, which will be described in detail later.

Needless to say, the TRS-80, marketed through the 7,000-store Radio Shack chain, quickly began selling thousands of units. The computer's low cost and ready availability and Radio Shack's expert marketing and service enabled the company to sell $10 millin worth of its computers during 1978.

PET

About the same time, Commodore Business Machines, Inc., a well-known calculator company, introduced its Personal Electronic Transactor, or PET. PET was the first completely self-contained home computer. Inside one cabinet were a nine-inch black and white video display, a cassette tape recorder slot, a 73-key keyboard, a Motorola 6502 microprocessor, and a power supply.

The PET made several important advances. First, the PET memory came with a large 14K ROM operating system, an 8K BASIC language interpreter, and a 4K RAM memory, more than twice as much internal memory as any other home computer in a similar price range. Second, the keyboard, simulating a typewriter keyboard, included a shift key, which allows manipulation of the video screen. For example, by pressing the shift and the letter Z, you can create a diamond shape on the screen.

You can create all four playing card shapes—heart, spade, club, and diamond—and dozens of lines, curves, and black and gray spaces to create pictures. Third, you can reverse the screen's field—that is, you can put white letters on a black background or black letters on a white background. And fourth, the PET provides a number of useful programming steps, such as assembly language programming.

The PET video screen has 25 horizontal lines and 40 columns for a total of 1,000 characters.

Selling widely for $750, the PET quickly became the second most popular home computer. Commodore realized early that its success would depend upon giving the public many interesting and useful programs. And PET realized the virtue of an easily understood, simple User Manual.

APPLE I AND II

While Commodore and Radio Shack were searching for the right way to introduce their machines, two young computer engineers were creating in a garage what has become the rags-to-riches story of the home computer revolution—the Apple II computer. In 1976, Steve Jobs and Steve Wosniak assembled a computer from scratch, and soon other engineers and friends wanted them to make computers for them, too. They literally took a flyer and with just a few thousand dollars advertised their computer and started a small shop.

Within months, their first model, the Apple I, had gained widespread praise in the new industry, and orders began to accumulate. The first version, which the very popular Apple II quickly superseded, had only 4K RAM memory. It was based on the 6502 microprocessor and had a full 53-key typewriter keyboard, a connection for a cassette tape device, and an internal video display monitor.

The Apple II offered the best available software and the greatest capabilities in the smallest package. Its biggest improvement and its best advantage was its color display. You could attach the Apple II to your home TV sets and get 16 different colors and produce any attractive graphics you wanted to program into the computer. It also expanded its RAM memory to 16K, added easy-to-use, plug-in connectors for many different peripherals, and allowed the novice to learn to use it in just a few hours. You could also expand the memory to 64K RAM. The Apple II inventors made sure it came with its own BASIC computer language.

Apple also provided two game paddle controllers or "joysticks," so new users could quickly learn to play games in color. The Apple II was more expensive than either the TRS-80 or the PET, but its advantages appealed to many people who wanted to use the computer in their homes and their professional offices.

OHIO SCIENTIFIC CHALLENGER

Halfway across the country from the Silicon Valley explosion, a small Ohio company introduced the Series 400 superboard, which can be turned into a home computer or used as the basis for a sophisticated microcomputing system. Ohio Scientific Instruments at first deliberately offered hobbyists a whole range of memory chips, video display, input/output boards, cassette interfaces, power supplies, cabinets, and other kit-type parts of a system. The OSI system was modular, so that a hobbyist could start with a $40 keyboard and work up to a complete system.

Like many small or new companies, Ohio Scientific was flooded by the explosion in demand for its microcomputer products. Then, it introduced its first home computer system, the Challenger IP and IIP. The IP was its first fully packaged home computer that you could plug in and use. It has a standard 53-key keyboard, a complete black and white video display capability (you have to add a monitor), audio cassette storage device, 8K BASIC in ROM, and at least 4K BASIC in RAM.

Its unique features rest on OSI's low-cost single-board architecture. It allows complete upper/lower case capability, sophisticated

graphics, including geometric shapes, lines, and game figures such as tanks, boats, cars, and so on, and fast operation. The Challenger gives a 64-character-wide column by 24-line video display in black and white.

Another Challenger advantage includes two unique capabilities: it can be equipped with either a Motorola 6800 microprocessor or a MOS Technology 6502 microprocessor, and it can use many different microprocessors at the same time through what is called a CPU expansion board. Thus, you can have a Z80 or any of several other microprocessors running off of the OSI Challenger at the same time. That means you can hook up many different home computers and their peripherals through the basic Challenger machine.

Soon after the Challenger IP was offered, OSI introduced a C2P and C4P version. They increase the number of ports through which you can add peripherals, such as printers, disk drive storage devices, and the like. With the IP, you could add only one peripheral at a time through one port.

COMPUCOLOR 8001

About the same time, a company specializing in intelligent terminals and large microcomputers, Intelligent Systems Corporation, near Atlanta, Georgia, introduced the second home computer capable of producing color graphics. The first version was called the Compucolor 8001, and it came with a 77-key typewriterlike keyboard (with certain important keys color-coded) and 11K ROM for its operating system and a BASIC interpreter, which makes programming easier. It came with an Intel 8080 microprocessor, 8K RAM, and a unique mass-storage system called Floppy Tape Memory, an eight-track cartridge. The color CRT (cathode ray tube) display had an impressive format of an 80-character column by 48 lines. And it provided eight colors, which could be reversed. Any of the colors can be used for the background, leaving the remaining colors for numbers, letters, shapes, and lines. The original price for the 8001 was close to $3,000, but the second version, the Compucolor II, The Renaissance Machine, is only $1,695 and a very useful machine as well.

EXIDY SORCERER

In the spring of 1978, another new Silicon Valley company, Exidy, Inc., introduced its Sorcerer, priced at about $1,100, with unique plug-in ROM Pac® cartridges. The cartridges contain the Sorcerer's programming languages, operating system, and applications programs. The Sorcerer's keyboard has 79 keys, including 16 keys for numbers, and allows upper and lower case letters. It has 12K ROM with a standard BASIC language and a basic 8K RAM memory.

It comes with built-in interfaces for a printer, cassette tape storage device, and communications. This computer must be connected to a video screen and a cassette tape. Its display provides 30 lines by 64 characters, a total of 1,920 characters, and black and white graphics with 256 different characters can be programmed, producing very detailed illustrations on the screen.

A New Era Had Begun

These six made up the first batch of successful home computers. Many others were announced, which either failed or were never actually made by their companies. In fact, many giants, such as Texas Instruments and Hewlett-Packard, watched and waited until the middle of 1979 and the beginning of 1980 to introduce personal computers.

Moreover, many companies that began serving the hobby market, such as North Star with its Horizon computer, turned away from home computers and emphasized small business systems. But interest in home computers slowly grew, despite setbacks because of a slow economy and a supply shortage of many types of integrated circuits for home computers. Companies that had been predicting that home

computers would be in every home by 1982 were revising their forecasts. They saw that the machines themselves had vastly outrun the uses to which the public could put them. In short, the general public asked the question we discussed in Chapter 1: "What can I do with a home computer?" In 1978, if you didn't know much about computers, the answer was, "Not that much."

While the companies were finding ways to appeal to the average person, they had already found an eager market—small business. Many small-business people had envied larger businesses for years because they could afford to buy word processors, computerized payrolls, data-base management systems, and the like. But the personal computer made it possible for a small-business person to buy a machine that would do general ledgers, run a credit and collection billing system, do the payroll, run financial analyses, and do dozens of other things for less money than it costs to pay a secretary in a year. A businessperson or professional would be willing to pay $5,000 to $10,000 for an advanced personal computer, a printer, a disk drive, and similar peripherals to accomplish these things—especially if he or she could take the same computer home at night so the children could play games on it or learn from educational software, and his or her spouse could do household money management chores.

But many companies found the public unwilling to pay large sums of money for those capabilities. That doesn't mean, of course, that today you won't find a computer that will be easy to use and relatively inexpensive. In fact, the second stage of the home computer revolution has begun. Businesses may spend $3,000 for a printer, but for half that much today, you can have all the same computer power and find hundreds of things to do with that power, examples of which will be found throughout this book.

Instead of having to learn computer programming you can learn to use the current crop of computers as easily as you operate your new stereo. Instead of confusing you with professional terms, advanced programming languages, and sometimes unkept promises, computer companies have made the home computer into just another home appliance. Everything you need to know is recorded on a cassette tape, a cartridge, or a disk; if you want to run your monthly budget, for example, you plug in a cartridge and follow simple instructions. Home computer companies have learned that most people want their home computer to be a tool that makes their lives more convenient and more interesting. They've realized that to sell home computers to the 10 million people who bought video games for $179 or less, they must make home computers as easy to use and as attractive and lively as those video games. And that they are finally beginning to do.

4. How to Buy a Home Computer

WHILE HOME COMPUTERS are getting easier to use, they aren't necessarily getting easier to choose. More than a dozen different home computers line store shelves, and more than 100 companies actively market home computer components—video monitors, memory boards, microprocessors, and so on—through more than 1,000 computer stores. Each fully assembled home computer differs from the next one in many ways. Most models cannot be hooked up to another model without special equipment; they are incompatible.

So you can easily become confused when you begin looking for your first home computer. And spending $500 to $2,000 for a basic home computer should make even the most knowledgeable and confident consumer stop and think before buying. If you go into a computer store or large department store without really knowing what you want, you could easily make a bad choice and unhappily coexist with the wrong home computer.

Six Different Kinds of Stores

Even if you have a firm idea of the make and model of home computer you want, choosing the right store to buy it from may present another bewildering problem. While the only store selling home computers three years ago was a specialty store run by knowledgeable, avid hobbyists, today—and tomorrow—home computers can be found in five other kinds of stores, including large department stores. None of the six kinds would give you a bad deal, but each kind of store has its own strengths and weaknesses. You can match your desires, knowledge, and strengths with a store that's compatible and begin a healthy, cooperative relationship that may help you get the best results from your home computer.

The six basic kinds of stores selling home computers today are:

COMPUTER RETAIL STORES — dedicated exclusively to selling and servicing many different home computers, with each one's peripherals, programs, books, and so on. Some also offer consulting services; most offer repair services. The Computer Factory in New York City is a good example.

RETAIL FRANCHISES — operating as retail stores but following standard operating procedures established by a parent company. They have the national marketing power and use the management expertise of the national franchise headquarters. Computerland, the largest franchise, has more than 100 stores.

SMALL RETAIL STORES — that sell home computers. Many small electronics, audio, television, hobby, and toy stores have added one or two types of home computer to their inventory, and operate one part of their store like a regular computer specialty shop. For example, Parks Hobby in New York City is a well-known toy and hobby shop, but it also runs an Ohio Scientific Challenger dealership. It has converted its basement into a computer shop and hired home computer professionals to sell, assemble, repair, and service the Ohio Scientific line.

MANUFACTURER'S STORES — exemplified by Radio Shack's 7,000 retail outlets, selling the company's own computers exclusively. Radio Shack sells its TRS-80 line in each of its stores and offers sales and support services through its regional service and repair centers and its factory. For selling small business microcomputers, IBM and Digital Equipment Corp. have adopted this method; DEC has opened 20 stores, and IBM some 30 outlets.

COMPUTER SHOPPING CENTERS — a unique marketing concept pioneered by Radio Shack and DEC. Radio Shack has opened 50 Computer Centers, which provide everything a TRS-80 owner or buyer would ever need or want in hardware, programs and software, maintenance, repair services, and professional advice. DEC has opened the first of many "One Stop" Computer Shopping Centers it plans. The Schaumburg, Illinois, center stocks terminals, printers, documentation manuals, floppy disks, ribbons, paper, printer wheels, cassettes, storage baskets, and disk packs. It also carries samples of spare parts, memory, and components, but customers order them directly through the center from the factory. Most experts foresee the computer shopping center as the wave of the future.

DEPARTMENT STORE CHAINS AND LARGE TOY STORES — Macy's has been selling home computers in its California stores for four years; it introduced the Texas Instruments 99/4 home computer in its East Coast stores and its Bamberger's chain in late 1979. Montgomery Ward is expanding its marketing of Ohio Scientific Challengers and Interact Electronics Model 1, Professional, and Professional Plus series; and Sears, Roebuck is marketing the Atari 400 and 800 lines throughout California and in Chicago, with plans to spread them nationwide very quickly. It already offers them in its current catalogs. Mattel's Intellivision was test-marketed in Fresno, California, department stores, and the Apple Computer has been sold in many different department stores for more than three years. Obviously, as more people buy home computers, more department store chains will add them to their lines.

Each type of store has its own advantages and disadvantages. To make the best buying decisions, you need to know how to be alert to and compensate for weak areas and use strong points to best advantage as you shop.

First, to avoid making a bad choice, learn about the fascinating panoply of home computers and pick the one that best suits your needs and increases your enjoyment. After all, you expect a home computer to be as convenient as—or more convenient than—your automobile, your television, your videocassette recorder, your TV video projection machine, or any other expensive, but fascinating, home appliance.

What Do You Want to Do With Your Home Computer?

Here are some basic guidelines to help you answer the most important questions about buying your first home computer.

DECIDE WHAT YOU WANT IT TO DO — First, and most important, decide carefully what you want your computer to do. A home computer offers hundreds of different choices, but each home computer has its own limitations. As you'll see, machines like the Mattell Intellivision® may offer little or no programmability. They depend on easy, preprogrammed tapes and cartridges instead. They also cost much less than more versatile models, such as the Apple II and the OSI Challenger. Although you can buy hundreds of programs on cassettes or floppy disks for these latter two, you'll need to study more and use instructional manuals and documentation manuals. But you can learn to program them with extra study and effort, and develop your own unique uses for them, which can be attractive.

So ask yourself what you want to do with your home computer now and in the near future (say, two to five years from now). You may become so fascinated and involved that you'll soon want a more difficult and versatile computer, while letting your children or grandchildren use your first one. Do you want your children to play games, learn reading and mathematics skills, or learn the basics of computing? Do you also want to manage your family finances or your food budgets and menus? Do you want to quickly learn computer programming and languages such as BASIC and Pascal? Or do you want to use your home computer in your small business or profession?

Each of these applications requires different computer capabilities. For example, to run a simple monthly household budget with 15 or 16 expense categories, you need only insert the Texas Instruments Household Management cartridge into the 99/4 and it will practically walk you through the budget each month. But if you own stocks and bonds and want to use a home computer to keep track of your portfolio, you may need the Apple II Stock Evaluator Package, which keeps track of a portfolio of 25 stocks but requires a floppy disk drive, a telephone modem, and a 32K RAM Apple II Plus computer. The required programs also cost a few hundred dollars for a total basic investment of about $2,500. Of course, this sophisticated Apple II Plus will also do practically everything else you would ever want it to. But only you can decide whether the cost will equal the machine's worth.

If you draw up a detailed list of what you want your first computer to do, you will save yourself time and trouble. When you first think about buying a home computer, decide that this purchase will result from a serious, thought-provoking process involving the whole family. Often, a father will spend $1,000 on a home computer because his teenaged son told him the machine would do everything he wanted. The only problem with this approach is the "he" in question; more likely than not, the machine will handle dating schedules and sports car maintenance, hardly what the father was looking for in a family computer.

WHAT CAN YOU OR WILL YOU PAY FOR YOUR HOME COMPUTER? — Finding the answer to this question is the second important step. If you're willing to pay $159 or $199 for a sophisticated video game, paying $399 or $499 for a useful basic home computer that plays all the games and does much more makes good economic sense. If you can use your home computer for your children's education, your household financial chores, and your own business as well, paying (and amortizing as a business expense) $2,000 for a sophisticated home computer also makes good economic sense. Between these extremes lie dozens of models, configurations, and variations of available home computers. And that variety and choice increases every month.

CONSTRUCT A BUDGET — When thinking through the total costs of a home computer, remember that buying the machine is just the beginning. You should include projected costs of maintenance (very little for many limited-use machines; regular service calls for sophisticated ones), and, more importantly, software and program costs. Prerecorded programs will usually cost from $9.95 to $49.95 for cassette-based programs and from $19.95 to $79.95 for programs recorded on floppy disks. Small business programs begin at $49.95 and go up as high as hundreds of dollars. And consider the out-of-pocket expense of buying exciting new game programs for you and your children, besides the practical uses.

Once you get started, you may want quickly to add peripherals such as disk drives, printers, light pens, telephone modems, speech synthesizers, music synthesizers, and many more. They all cost money; modems, for example, start at about $99 and go up to about $300.

One common problem many people experience leads to the purchase of an extra color

video monitor. Junior may want to play Tank Battle while Dad wants to watch the World Series or the Super Bowl. One answer is to buy a home computer with its own screen, or another monitor. Black and white monitors cost from $139 up; color ones start at about $300.

Another important factor to add to your budget is an estimate for maintenance. A computer is just another machine, albeit a very reliable one, and requires occasional tune-ups and maintenance and sometimes major repairs. These will cost you something, but you can get a reasonable service contract from many dealers.

EXAMINE AND COMPARE YOUR INITIAL CHOICES — Using this book and computer magazines (listed in the bibliography), begin examining the available home computers to determine which choices fit your desires and budget. Go to local computer stores, shopping centers, department stores, or wherever you can buy home computers.

Compare each machine's features: the keyboard, the screen graphics, the mass storage medium, all the obvious things. Don't forget to look at the computer's user's manuals and guides. Make sure they're well written and easy to understand. Many novices think it's their fault if they don't understand a manual, but that's not necessarily true. The company may have provided a badly written and incomprehensible manual.

Carefully compare features, but don't compare apples and oranges. Remember that one computer with 4K RAM has only the same memory capacity as another 4K RAM machine. Don't compare a 4K RAM machine with a 32K RAM machine, a machine with an eight-bit Motorola 6800 microprocessor with a machine with a 16-bit TI 9940 one. And tread cautiously, because no standard exists for comparing personal computers, and most home computers do not work with another system without special equipment.

A good approach includes taking along a written checklist of features and choices important to you.

"TEST DRIVE" THE COMPUTERS — Although many people scoff at test driving cars before buying one, "test driving" a home computer before you buy it—along with all these steps—will give you the best feel. Just as intangibles influence buying a car—seat comfort, windshield angle, knee and leg room, and so on—similar intangibles should influence buying a home computer. If two machines have similar features and prices, but you don't like the keyboard or the color of the one the dealer favors, don't buy it. The idea is to get a machine that makes your life more pleasant, and that includes esthetics.

During the test drive, you should ask the dealer specific questions about the merits and deficiencies of each computer you're interested in. Retail computer stores, such as The Computer Factory and The Computer Mart of New York, offer a wide variety of machines, while a "shopping center" may carry only one and a department store may carry two or three selected machines. You may have to spend a couple of Saturday afternoons or weekday evenings to get a clear idea of the machines available in your area.

STUDY WARRANTIES AND SERVICE CONTRACTS — Once you've narrowed your choice down to one or two computers, get a copy of the manufacturer's warranty and read it carefully. Most home computers have a complete 90-day warranty that covers everything; some contain a partial warranty on certain parts for nine more months.

Many retail stores and dealers offer warranty service, if the manufacturer has made them authorized dealers and service centers. Otherwise, you may have to return your computer to the factory for service. However, many companies, particularly Radio Shack, promise a quick turnaround on broken machines; Radio Shack has been offering 24-hour turnaround on minor problems.

Atari and Mattel have begun two significant changes in home computer servicing. Atari has signed up a computer giant, Control Data Corp (in Minneapolis, Minnesota), to service its 400 and 800 computers through its 20 regional service centers. And Mattel has asked General Electric Corporation, the electronics and home appliance giant, to repair its Intellivisions through its local servicemen. In certain cases, a GE serviceman may come to your home, insert a diagnostic cartridge into your home computer, spot the bad IC chip, unplug the board or chip, and simply plug in a new one.

Radio Shack retail stores have also taken a different tack, as have some retail franchise and "shopping centers." They offer service—on an annual contract or individually—at their centers or regional service centers.

On the other hand, many small computer stores make much of their profit by offering both warranty and regular service. In the future, small home computer repair shops will proliferate, just as TV and radio repair shops spread rapidly throughout the 1950s and 1960s.

Although you must expect your computer to need maintenance, you probably won't have to wait long for repairs and service. The home computer industry recognized in 1978 that the average consumer would demand quick service; before that, hobbyists often had to wait weeks or months to get a broken computer back from the factory.

AN IMPORTANT NOTE ON PROGRAMS: — Few companies guarantee or give any kind of warranties on its cassette or disk-based programs. Some software companies, such as Muse Software in Baltimore, Maryland, will replace certain program disks if they wear out, but they usually add a small charge (20 percent of original price is common). Few, if any, software companies provide any kind of guaranteed replacement on cassettes. (The exceptions do so to maintain good customer relations.) Be sure to check.

DETERMINE THE NORMAL START-UP PROBLEMS — Just like a car, a home computer may have "kinks" when you buy it. Most retail shops, centers, and franchises break in a home computer, making sure it operates correctly before you take it home. Department stores may not have that capability. Make certain to ask your dealer or store what start-up problems you should expect, and make sure the dealer or store will help you fix these or other trouble spots.

CHECK THE MANUFACTURER'S REPUTATION — While you determine these other factors, you should also look into the reputation of each manufacturer. Go to user's groups and hobbyist clubs, read magazines, check with friends and even the Better Business Bureau to see if you can find a chink in a company's customer service armor. Today, manufacturers' reputations do not constitute as big a problem as they did several years ago, when many small companies emerged overnight and failed to make prompt delivery and could not give good service.

If you choose to buy a home computer or peripheral by mail order, closely reviewing a mail order distributor's or manufacturer's reputation becomes essential. As a rule of thumb, ask a mail order house for five to seven independent references in your area and call them. If a mail order outfit balks at providing references, you might want to avoid them and stick with a nearby store.

If you follow this eight-step buying plan, you can make a satisfying, intelligent buying decision. After all, home computers should entertain and enlighten you, not force you to waste your leisure time in a repair shop.

PART TWO

The New Generations—1980 and Beyond

Home computers are rapidly reaching millions of homes in the United States and abroad. New models, at relatively lower prices and with sharp gains in computing power, continue to burst onto the marketplace and will continue to do so for many years to come as home computing attracts a huge market, despite skeptics' criticisms.

In fact, Interact Electronics has confounded the critics with new statistics. Although only 70,000 home or personal computers had been sold by 1978, the total skyrocketed more than 500 percent by mid-1980 to more than 400,000—an impressive figure. But the Interact Statistics don't stop there: "If the number of units seem relatively small in comparison to other consumer electronic items (10 million electronic games, 70 million pocket calculators), consider that the number of personal computers built in 1978 exceeds by 50,000 units the world's total population of computers in use in 1973, which was 205,000 units." The company also predicts that by 1982 there will be in U.S. homes 10 times as many computers as there were in the world in 1973. Or consider these figures: consumers spent more on personal computers in 1978, 1979, and 1980 than on black and white televisions, dishwashers, microwave ovens, electric hairdryers, or many other heavily advertised consumer items.

Truly, a remarkable change in our way of life continues to gather momentum. Part Two, "The New Generations," describes all the newest home computers and discusses how the newest and the best-selling home computers are reaching out to the public to provide hundreds of interesting ways to use these "mind appliances." Here you will find out in detail how you can turn your home computer into an information utility and a "window on the world."

These first home computers are as easy to use as your audio equipment or pocket calculator.

5. The Newest Home Computers

THE NEWEST HOME COMPUTERS pack amazing punch into smaller and smaller packages. And you don't have to know anything about computer programming or the internal workings of a computer to run them. Manufacturers are filling up the newest computer's ROM memories with all the instructions needed to lead you through the operations step by step.

Prices of the newest home computers have stabilized (with one new, notable exception) at about $500 for a basic machine. Sharp competition has encouraged manufacturers like APF Electronics and Interact Electronics to pack more capabilities, such as color graphics, music, and twice as much RAM memory, into a package that costs about the same as or less than the best-selling established home computers. You may not see a tremendous price break—with double-digit inflation, increases in some computers' prices may be inevitable. Large companies, such as Hewlett-Packard, are carving out these niches in the marketplace.

Even more significantly, every manufacturer has realized that a home computer must work as a general-purpose machine that you can use for dozens of different applications. They realize that the key to success does not rest with fancier machines, but with more and more useful programs on cassette tapes and cartridges. Mattel, APF, Interact, Bally, and Texas Instruments are introducing dozens of new application tapes and cartridges each year. These programs appeal to the broadest possible audience; each company has conducted extensive and expensive market surveys to find out what you want. As they see that you want more, they'll find ways to provide more.

Within five years, perhaps the most significant way to provide more programs than anyone in 1975 ever dreamed possible will begin. Videodisks, such as the RCA Selectavision (just coming on the market) and the popular Magnavox videodisk, can store millions of bytes and hundreds or thousands of computer programs. Again, the main problem remains the same: a variety of good programs to fill up thousands of $30 disks does not yet exist.

But compare the potential of videodisks to mini-floppy disks. A videodisk player costs about $500–$800; mini-floppy disk drives cost about the same thing. But a mini-floppy can store a maximum of only 150,000 bytes compared to a videodisk's millions. Floppy disks have one primary advantage—you can load and retrieve programs from them. Videodisks serve only as mass storage for fixed programs, but, in that respect, they do not differ from TI's Solid State Modules® or H-P's Application Pacs.® On the other hand, video tapes for videocassette recorders can load and retrieve information, so that they, too, promise significant mass storage devices soon.

But remember, home computing changes every month. New machines are introduced. New peripherals for existing machines become available. New programs and new applications develop. And 30,000 more people—maybe you or your neighbors—buy their first home computer. Rapid, unpredictable, and intriguing change will remain the hallmark of home com-

The RCA Selectavision video disk will be introduced in early 1981. At first, its applications will be for low-cost movies, rock concerts, and other entertainment, but it could have a bright future, too, as a huge library of computer programs. One video disk could easily hold up to 1,000 programs for home computers. (Courtesy of RCA)

puting for many years to come. With that in mind, let's examine the latest crop in the home computer field.

Sinclair Research Microcomputer

Sinclair Research Corporation, 50 Staniford Street, Suite 800, Boston, MA 02114

Sinclair Research, which first introduced mini-televisions and pocket calculators, has done it again, this time in home computing. It has introduced a very small and very light home computer, priced at only $200, that may have more power and capabilities than the Radio Shack TRS-80 Level I and the Atari 400.

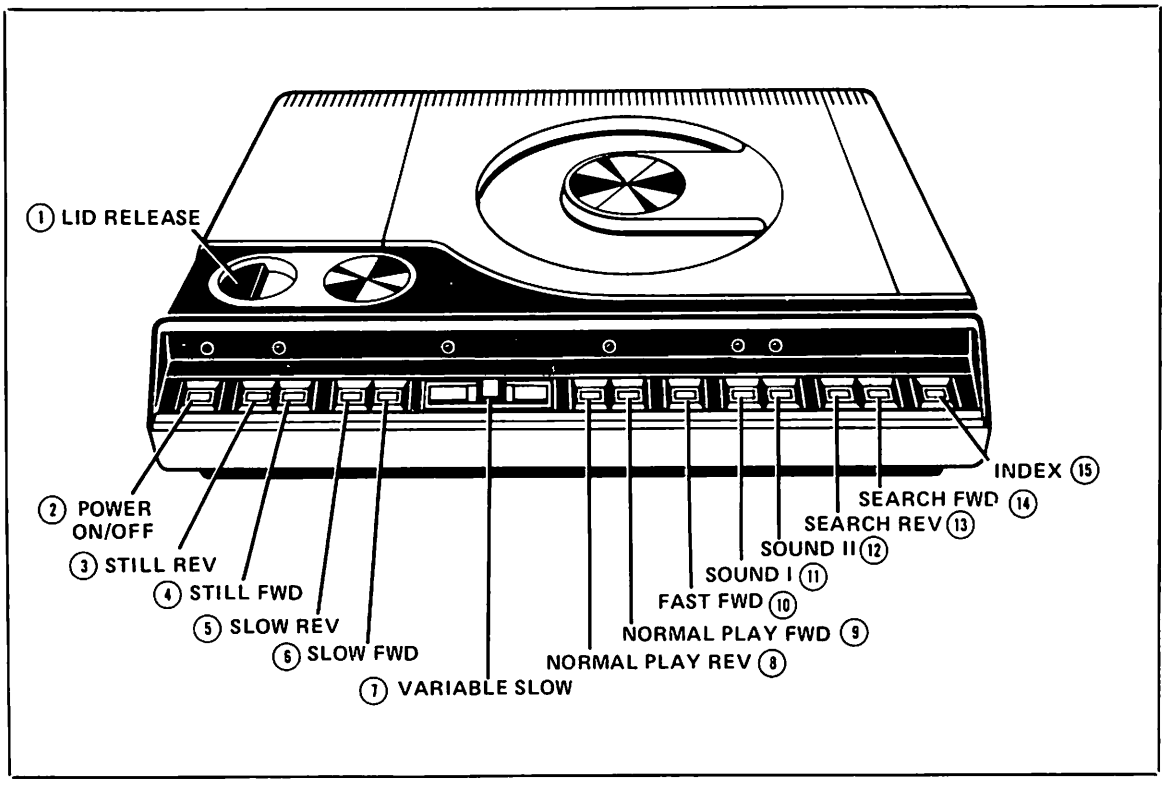
The rectangular computer is about 8 inches by 6 inches by 2 inches and weighs less than a loaf of bread. It has a pocket-calculator-like touch keyboard and comes with a 4K RAM memory, but it can be expanded to 16K. Users

have to plug it into a black and white or color television and provide a cassette recorder for mass storage, but Sinclair provides all the wire leads and cables with the computer, unlike some companies, which treat them as options. It has an eight-bit Japanese ZX80A microprocessor and its language is a BASIC interpreter.

Its most unique feature consists of plug-in ROM cartridges for upgrading with more memory and packaged user programs. Company officials say that the unit is modular, so that it can be easily upgraded and expanded with plug-ins and cartridges.

Sinclair crammed so much power into so little space (it's smaller than many electronic games) by eliminating a lot of hardware, driving the video display through the microprocessor rather than through its own separate circuitry, for example. And it sharply reduced the number of components within the whole system, using Sinclair's advanced research techniques.

As Sinclair insists, this book-sized home computer is no toy. It takes the first giant step toward the future, when home computers will become the size of miniature pocket calculators that fit in a shirt pocket.



Block diagram of the Magnavox video disk, which has been marketed in certain cities for more than two years. The diagram describes the simple controls for video disk operation. (Courtesy of Magnavox)

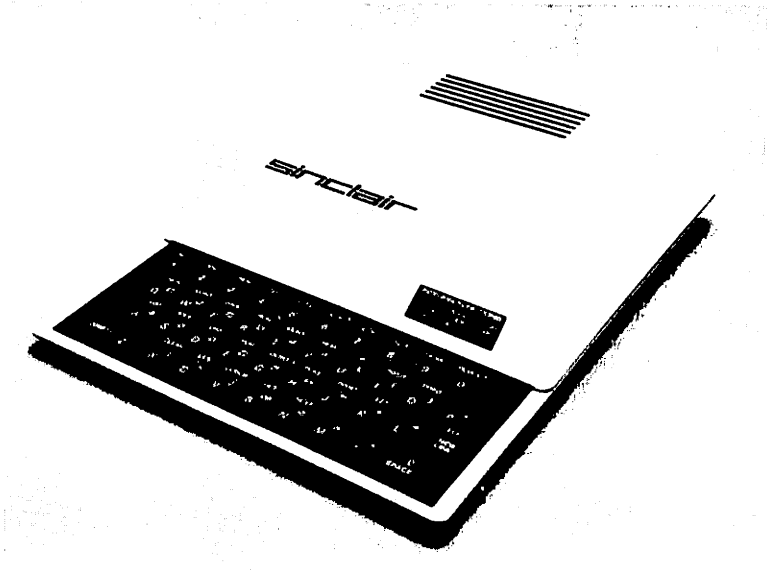
The Imagination Machine

APF Electronics, Inc., 444 Madison Avenue, New York, NY 10022
SERVICE CENTER: *43-28 37th Avenue, Long Island City, NY 11101*

The APF Imagination Machine has introduced several unique features to the home computer field as a computer with mass appeal. Priced at $599, it is designed as a simple consumer product. The Imagination Machine comes in two parts: an entertainment module with two joystick controllers and ten-number keypads for game playing; and a computer console with a 53-key standard typewriter keyboard for personal computing. It has a large internal ROM of 14K bytes and 9K RAM bytes, a 32-character by 16-line video screen format, a built-in cassette deck, a built-in music synthesizer, and a powerful internal operating system and BASIC language interpreter.

You can either program the Imagination Machine yourself using a very easy BASIC language and unique programming commands, or use APF's extensive library of about 30 versatile cassette-recorded programs. In fact, the APF Imagination Machine is the first home computer that can store both programs and your input on the same cassette tape. With other home computers, you must "read" programs from one tape into the computer and "write" or load your information, such as budgets and household accounts, onto another tape. But the APF machine eliminates excess storage and the need to buy new tapes because the computer automatically loads your input onto the tape which holds the program.

For example, to save personal information you've entered into the computer and displayed on your home television, you simply type in "C SAVE." The computer will record the information onto the tape. When you use the same cassette again, you slip the cassette into the tape system and operate the load function, and the computer finds both the original program and your information on the same cassette. APF offers at least 15 different programs with this feature.



The new Sinclair Microcomputer ZX80, the smallest home computer on the market, is a good example of a future trend toward miniature home computers. It is 8 inches by 6 inches by 2 inches thick and weighs 12 ounces. (Courtesy of Sinclair Research)

The new APF Imagination Machine is designed as both an entertainment center and a home computer. It comes with two joysticks, ROM cartridges, a built-in mass storage device, and a full keyboard. (Courtesy of APF Electronics)

EASY KEYBOARD COMMANDS

A second unique feature makes programming much easier. Across the top of the keyboard, 24 different programming commands are printed. Using the shift key, you can enter these commands into your programming instructions. You have to have the APF BASIC cartridge in the machine in order to program it in BASIC. But learning BASIC with APF's instrucition manual frees you of the fear difficult professional manuals can cause. (See Table 1 for an example of a simple program to play music. It was written using APF's unique command features.)

A third unique feature of the machine allows the computer automatically to adjust to the user's skill level. Operating through internal mathematical formulae called algorithms, the computer will, for example, determine how easy or difficult you find its Math Tutor program. APF calls this learning feature the Personal Performance Response and uses it to offer more challenging problems to develop math skills. If you're slow, the computer will compensate with

TABLE 1 MUSIC PROGRAM FOR THE IMAGINATION MACHINE

```
10  SHAPE =15
20  FOR I=0 TO 7
30  COLOR =I
40  HLIN I,31-I,I
45  MUSIC "100"
50  HLIN I,31-I,15-I
60  VLIN I,15-I,I
70  VLIN I,15-I,31-I
80  NEXT I
90  MUSIC "321322133321321"
100  GOTO 10
```

This 11-step computer program plays music and shows how to use APF's simple, easily learned command features. Children and adults can learn to program the Imagination Machine in minutes with a clear, concise programming guide. (Courtesy of APF Electronics)

easier problems. It offers this "learning response" in all of its tutorial programs.

OPERATIONAL EASE

Getting the machine running takes about as much know-how as hooking up a new stereo in your home or a tape deck in your car. Just connect the MP 1000 entertainment console to your home TV through a simple adapter, and plug the computer console into the MP 1000 with simple jacks. APF provides easy-to-read instructions and guides you through a series of simple steps to check out each console and learn how to load program tapes. The owner's manual has only 20 pages and it's filled with diagrams.

Each program cassette comes with an instructional pamphlet, and APF has made sure that young children can read and follow the instructions. For example, in six pages, APF shows how to load the Music Composer/Player Piano tape, select and play prerecorded songs, write songs, and play them back like a player piano. It also shows how to edit music you've composed and combine music and messages for a musical message board.

BUILDING BLOCK AND OTHER CREATIONS

APF takes advantage of its computer's power. The Imagination Machine can be expanded into a full-fledged personal computer system with many optional cartridges and peripherals.

The keys to these options consist of an 8K RAM memory cartridge, which increases from 9K to 17K the available RAM, and the Building Block, APF's name for an expansion interface. The Building Block (for about $200) has four universally adaptable ports into which you can put peripheral drive cartridges. Included with the block is a cartridge that allows you a telephone modem or any standard printer hook-up. Optional ports can hold an 8K RAM memory cartridge and mini-floppy disk drive cartridges.

THERMAL PRINTER — APF offers a 40-column thermal printer that prints two lines per second (a total of 80 characters—a fairly fast speed). (Suggested retail price, about $400.)

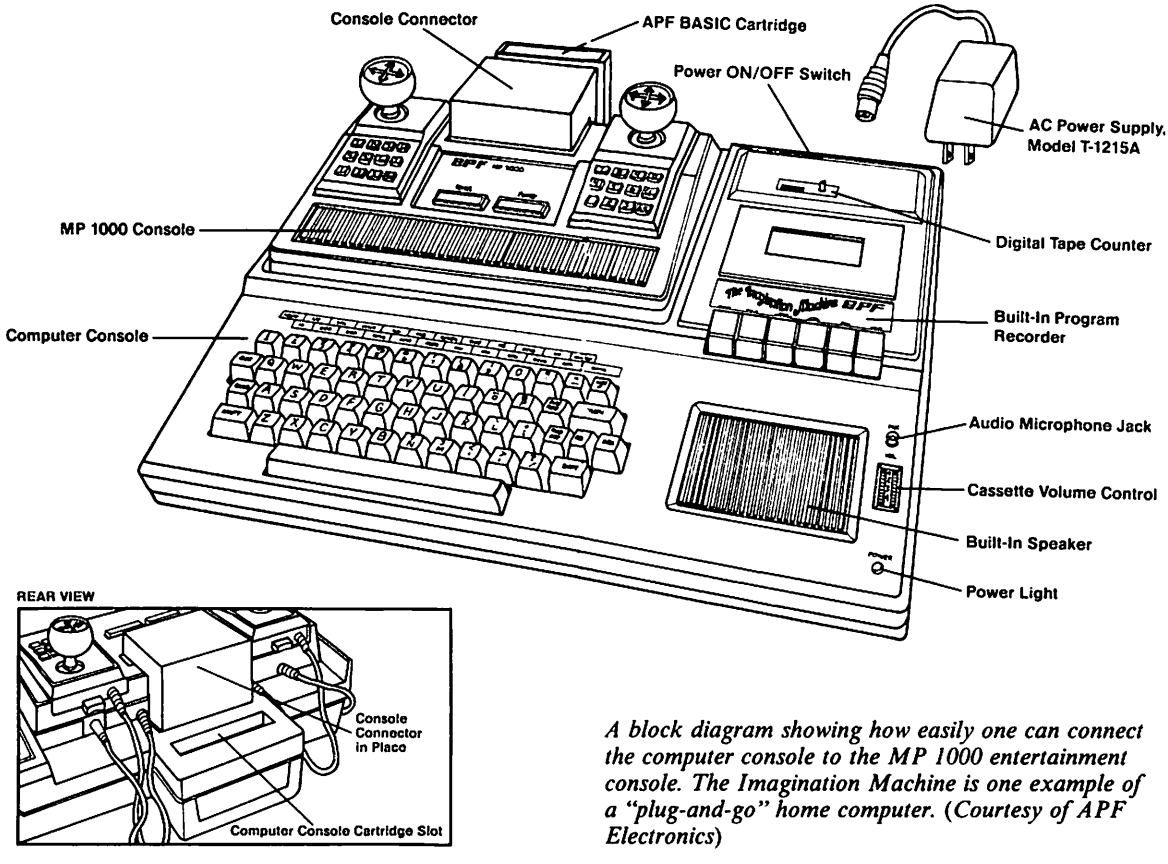
MINI-FLOPPY DISK DRIVE — Each mini-floppy disk drive can hold 72K bytes of added data storage and loads or reads information in seconds. (Suggested retail price, $350.)

TELEPHONE MODEM — The modem is a standard one that allows you to hook up to time-sharing services like the SOURCE or MicroNET, or share programs with a compatible computer. (Suggested retail price, $200.)

The retail price of the two consoles should range from $500 to $600 for both. The RAM memory cartridge costs about $100, the mini-floppy drive cartridge, $200.

AVAILABLE PROGRAMS

By mid-winter 1980, APF will offer a wide variety of programs, from six to eight each



A block diagram showing how easily one can connect the computer console to the MP 1000 entertainment console. The Imagination Machine is one example of a "plug-and-go" home computer. (Courtesy of APF Electronics)

quarter. Its program offerings will include: Typing Tutor; Artist and Easel; Checkbook/Budget Manager; Music Composer/Player Piano; Personal Business Machine; Computer Lab; and Adventure Castle. See the Appendix for a complete list of cassettes and programs for the Imagination Machine, the first salvo in the war to bring computer power into your home.

You can buy the Imagination Machine through many audio, discount, department, computer, and radio/TV stores and catalog showrooms. It was the first dual-console home computer to hit the mass market and its success seems assured. APF has created a no-fuss, no-muss, no-fear home computer.

Interact Model One, Standard Professional and Professional Plus

Interact Electronics, Inc., P.O. Box 8140, Ann Arbor, MI 48107

Interact Electronics has introduced a slender, compact computer with a built-in cassette tape deck and a 53-key slanted typewriter keyboard. It has a powerful eight-bit Intel 8080A microprocessor with a 2K ROM internal operating system and a large 16K RAM memory. It works through a home color television set and generates eight colors, three octaves of sound, and hundreds of different tones. It comes with two joystick controllers for games (without a numbered keypad).

The Model One computer comes in three variations, each of which has more power and versatility than the previous one. The Model One Standard has the features described above; the Model One Professional adds a standard RS232 peripheral interface for any compatible printer, or other compatible peripherals as Interact develops them. It also has a port for a telephone modem.

The third model, the Professional Plus, upgrades the computer to 16K ROM and 16K RAM, including Level II BASIC, a program editor, and software needed to run a printer. Programmable RAM effectively expands to 13K RAM from the 4K RAM of the Model One, and the BASIC language works at the touch of a button because it has been stored in the expanded memory.

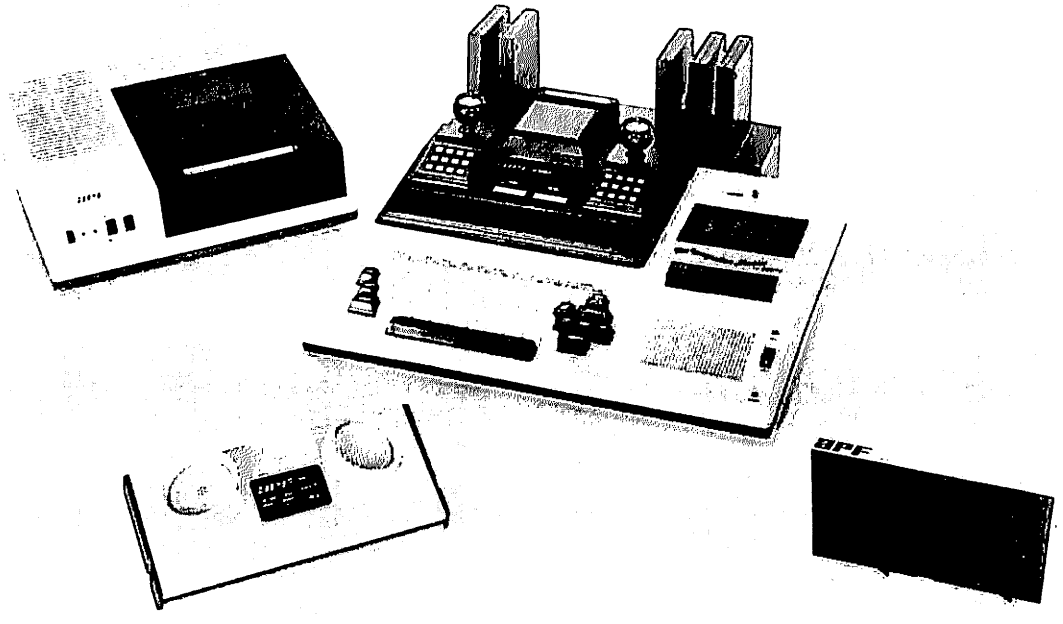
Interact currently offers only a small thermal printer as a peripheral, but may have a telephone modem on the market by late 1980.

KEYBOARD OVERLAYS AND BASIC OPERATIONS

Interact has transformed its entire keyboard into a large game and entertainment keypad. You can overlay a paper guide and turn the keyboard into a miniature piano with its Music Maestro program, or any of several other games or entertainment programs. An owner can use the keyboard for many different applications without remembering exactly which key performs each function. With this feature, Interact has borrowed a common TV video game procedure, which makes the games much more exciting and different, as well as easier for children.

Interact has made its operating Family Computer models as easy as possible, relying on your desire to avoid learning programming, although it makes available an interesting new

The APF Imagination Machine with all its peripherals, including a 40-column printer, a dual disk drive, and a telephone modem. (Courtesy of APF Electronics)



program editor called EZEDIT which helps you learn and run Level II BASIC programs much faster. But you have to have the Professional Plus model to run EZEDIT. Otherwise, operating all the three models requires attaching an adapter to your television set, plugging in the joysticks and loading cassettes. Each program cassette for the first two models comes with its own instructions. Manuals to learn BASIC programming are optional.

PROGRAMS AND PROGRAMMING

The Model One can also be programmed, and its 4K RAM memory provides enough RAM for most people just learning to write short programs. But the Professional Plus model provides a versatile and powerful programming package. You can add program names to the program and the computer will automatically locate and load the desired program after you record it. It provides a number of "control" keys with which to start and stop listings, so that you can review programs too long to fit on the screen, and it allows you to enhance applications, program four colors at once, and plot color graphs with complete freedom to put a desired color at any of 8,624 points on the screen. You can also add music and sounds to any program you write and take advantage of full mathematic functions with accuracy of up to seven digits.

The EZEDIT program editor reduces the number of syntactical errors new programmers make and allows use of English words to perform program functions. For example, a LOCATE command finds a number, word, or group of words anywhere in your program; you don't have to list your whole program and search through each line. A SUBSTITUTE command lets you change lines with one command, without retyping the whole line to correct errors. EZEDIT has 13 basic commands, dozens of variations, five special control characters, 75 reserved BASIC language words, and six arithmetic operators. In short, the EZEDIT program enables you to quickly learn Level II

TABLE 2: SAMPLE PROGRAM FOR INTERACT HOME COMPUTER

```
10  CLS:OUTPUT "DEPRECIATION",15,-
    40,2
20  OUTPUT "ROUTINES",30,30,2
30  OUTPUT "READY?",3,15,2:A$=
    INSTR$(1)
40  CLS:OUTPUT "1 STRAIGHT-LINE",
    4,50,2
50  OUTPUT "2 DOUBLE DECLIN.",
    4,40,2
60  OUTPUT "3 SYD METHOD",4,30,2
70  WINDOW 18:INPUT "METHOD";I
80  IF I<=3 AND I>=1 GOTO 100
90  PRINT"1,2 OR 3 PLEASE":GOTO 70
100  CLS:WINDOW 77
110  PRINT "STARTING":INPUT
     "VALUE";V
120  PRINT "USEFUL":INPUT "LIFE";N
130  CLS:ON I GOTO 140,150,160
140  PRINT "STRAIGHT-LINE":
     PRINT:GOTO 170
150  PRINT "DOUBLE-DECLINING":
     PRINT: GOTO 170
160  PRINT "SYD METHOD":PRINT
170  PRINT "YR DEPR. VALUE"
180  J=0
190  ON I GOTO 200,300,400
200  REM S-L CALCULATIONS
210  D=V/N
220  V=V-D:J=J+1
230  PRINT J; SPC(1);D;SPC(2);V
240  IF J<N GOTO 220:END
300  REM D-D CALCULATIONS
310  D=(2/N)*V
320  V=V-D:J=J+1
330  PRINT J;SPC(1):D2;SPC(3);V
340  IF J<N GOTO 320:END
400  REM SYD CALCULATIONS
410  F1=V/(N*(N+1)/2)
420  J=J+1:F2=N-J+1
430  D=F1*F2:V=V-D
440  PRINT J;SPC(1);D;SPC(3);V
450  IF J<N GOTO 420:END
```

The program above calculates depreciation on real estate, cars, equipment, or anything that declines in value and concerns real property, by using your choice of the straight-line, double-declining balance or sum-of-years-digits method.

The Interact Home Computer comes in three models: Model One, a Professional Model, and a Professional Plus. Interact has provided dozens of program cassettes for its new computer, and one does not have to learn programming to use it. (Courtesy of Interact Electronics)

BASIC and reduce the time and effort spent writing your own programs.

Interact provides an excellent, clearly written Level II BASIC Language User's Manual, and provides many sample programs.

One of Interact's strengths is that it recognizes consumers' demands for many useful programs. Among more than 30 program cassettes now available, Interact provides—for all its models—professional-quality programs, such as two Financial Libraries, including "Portfolio Reporter" for stocks and bonds; sophisticated simulations, such as Hammurabi, in which you act as a potentate and try to keep your population alive, fed, and growing; and a complete education series, including separate cassettes that teach fractions and logic, both more advanced math and applications than many other computer makers offer. For a complete list of Interact's programs, see the Appendix.

POSITIONING AND PRICE

Interact has deliberately positioned and priced its three models to compete with computers such as Radio Shack's, APF's, and Mattel's. The company has taken advantage of many advances to offer versatility equal to or better than those at a similar price. The Model One Standard costs about $500, while the Professional model lists at about $600 and the Professional Plus for about $700, less than the TRS-80 Level II and the basic Commodore PET.

Program cassettes range in cost from $8.95 to $19.95, all competitive prices. Interact has said that it intends to grow as rapidly as possible and

provide an ever wider library of applications. And the Interact model avoids one important shortcoming of many other home computers: a Model One can be upgraded to a Professional Plus by adding the required interfaces purchased at a computer store or through the factory. Interact says it wants its computer owners to grow with the company and add to their computers as they learn more and want to add more capability.

Mattel Intellivision

Mattel Electronics, a Division of Mattel, Inc., 5150 Rosecrans Avenue, Hawthorne, CA 90250

The Mattel Intellivision, an "intelligent television," takes a remarkable leap forward and includes voice recognition, a very difficult ability to produce with current home computing technology. And it combines a master component entertainment console and a full 60-key typewriter into a Personal Computer Network. But by late 1980 it could not be programmed.

The Intellivision uses a sophisticated 16-bit General Instruments microprocessor, which offers a full range of sharp, simulated sound effects, three-part harmony, extremely sharp

Mattel's Intellivision Intelligent Television combines a Master Component—an entertainment center—with a keyboard component, which turns the unit into a powerful 16-bit home computer. (Courtesy of Mattel, Inc.)

color TV pictures, and very high graphics resolution.

The *master component* has two 12-button, hand-held controllers, each with four play-action keys (similar to those found on Mattel's hand-held electronic games), and a 16-direction control disc that precisely moves objects on the TV screen. Each of the component's more than 20 preprogrammed cartridges comes with two paper overlays, one for each controller. The *keyboard component,* unlike the master component, uses programmed cassette tapes through a digital cassette system with computer-controlled fast-forward and tape search.

Overall, the Intellivision has more than twice as much computer power as a Level 1 TRS-80, but the difference centers upon what Mattel has chosen to do with that power. Mattel has reasoned (correctly, I believe) that its market—millions of average consumers—wants entertaining and exciting sounds, colors, music, and graphics. So Mattel has burned into the Intellivision's ROM memory all these capabilities and more.

Mattel has produced remarkably lifelike color graphics and realistically simulates movements of people and animals in its entertainment and games. In its basketball game, computerized men jump like Pistol Pete Maravich and block shots with the grace of Wilt the Stilt. In a child's math tutorial, an amusing gorilla gets dumped into a flowing river when a child gives an incorrect answer to simple addition or subtraction problems. Each of its 20 entertainment cartridges has similarly impressive sights and sounds.

Initially introduced in early 1979, the Intellivision suffered from supply shortages, as so many other home computer makers did in late 1979, and did not reach national markets until late 1980. Mattel tested the master component in Fresno, California, during Christmas 1979, but won't introduce its keyboard segment until early 1981. And then the company had only eight keyboard component programs: Federal Income Tax Preparation; Dr. Art Ulene's Weight-Loss Program; Jack LaLanne's Physical Fitness; Speed Reading; Jeane Dixon's Astrology; Stock Analysis; Guitar Lessons; and Conversational French.

SPEECH SYNTHESIS

The Conversational French program cassette shows the Intellivision's remarkable, yet untapped, potential. The computer recites French words and phrases to you; you repeat the word or phrase into a microphone that comes with the unit. Your pronunciation is stored on the cassette tape. Then, the computer repeats the word so you can hear it again. It *simulates* voice recognition, but does not actually recognize the spoken word. However, it does not include an advanced speech synthesizer.

To know how to speak, the computer must "hear" the human voice spoken, break down the voice into its parts, called "phonemes," and remember them. As you'll see in later chapters, only Texas Instruments and the Japanese can compare to the speech synthesis capabilities of Intellivision.

At this time, the Intellivision remains and impressive machine with huge, untapped potential. Mattel spokesmen have said they plan to make the Intellivision programmable by 1982, and they look forward to introducing eight to ten new cartridges for the master component and eight to ten more for the keyboard component each year. They plan to add more language cassettes, such as Conversational German, and hardware peripherals such as a modem, a printer, and disk drives within a few years. The dates these will be introduced will probably depend on how the public reacts to the machine.

It remains to be seen whether Mattel's huge advertising budget and marketing force can help the Intellivision recover from its slow start.

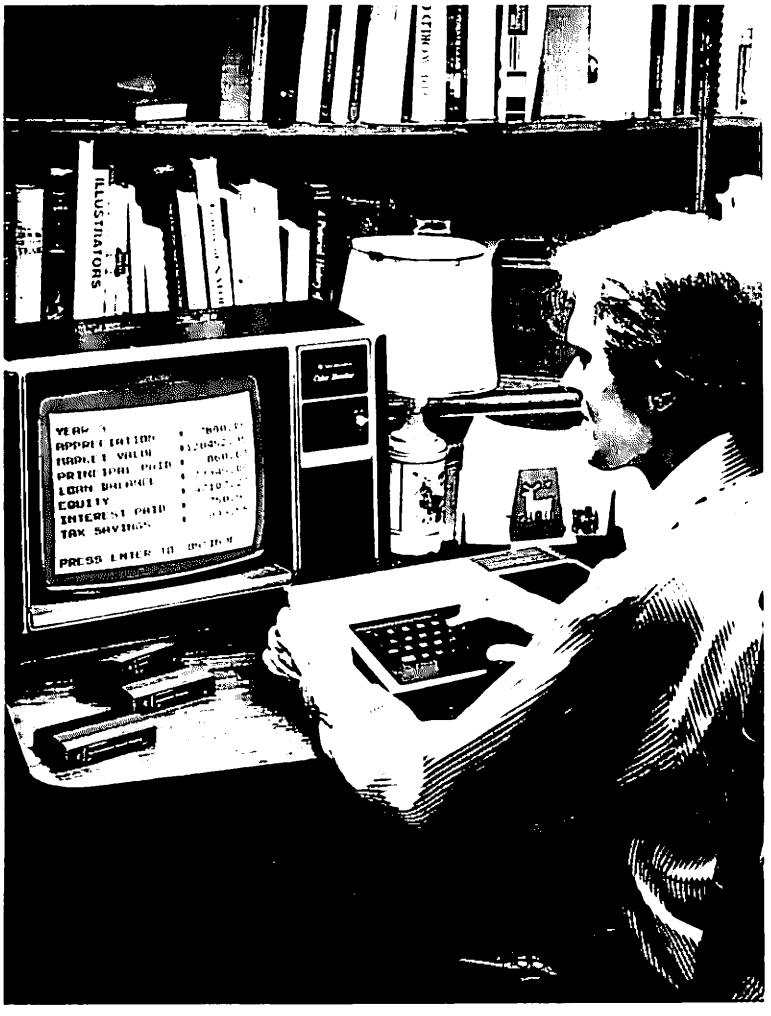
The components have a suggested retail price of about $250–$300 each. The cartridges and cassettes will cost from $19.95 to $39.95 each. See the Appendix for a complete listing.

Texas Instruments 99/4 Home Computer

Texas Instruments, Inc., Customer Relations, Box 53, Lubbock, TX 79408

Texas Instruments became the first important computer company to introduce a home computer in late 1979. From the start, the long-awaited Texas Instruments announcement emphasized that the company would sell a family-style computer with unique, powerful "instant" computer programs. And although the personal computer industry, which had built up many fantastic expectations about the TI machine, at first was disappointed, it has become apparent that Texas Instruments' 99/4 Home Computer has more potential than any similar machine. Texas Instruments has assured the public that it will use its mighty research and development facilities to produce a whole family of home computers, Solid State Software,® and peripherals.

TI slowly introduced the 99/4 in late 1979, missing the holiday season. But the 99/4s began spreading through TI's national distribution network in 1980, and TI promises to quickly become—and remain—one of the two or three



Texas Instruments' 99/4 Home Computer is the first home computer introduced by an important computer company, rather than a new or consumer electronics company. It is based on a powerful 16-bit microcomputer and requires no knowledge of programming for someone to use it. Texas Instruments has provided Solid State Software® in ROM modules. (Courtesy of Texas Instruments, Inc.)

most important home computer companies. Within six months, it had significantly upgraded the 99/4's power and capacity. TI made it expandable to 64K RAM in 42K increments and added an extended BASIC language module for more powerful operations. More significantly, it began selling the computer keyboard, without the monitor, for $950. It priced the monitor separately at $450. The total price of $1,400 is $250 more than the original price.

SOLID STATE COMPUTER POWER

The 99/4 is based on Texas Instruments' own TI9940 16-bit microprocessor, making it more powerful and more versatile than the Intellivision. Agreeing with the same marketing principle that guides Mattel, APF, and Interact, Texas Instruments applies its own sophisticated approach to providing computer power to a public that doesn't want to learn programming. That answer consists of its Solid State Software® modules. Inside each module, up to five ROM chips with 30,000 (30K) bytes of memory give a user instant access to two dozen programs. You simply plug the module into the computer's keyboard console and your computer is ready to use. You don't have to wait for tapes to unload; the 99/4's huge internal operating system instantly reads the module programs.

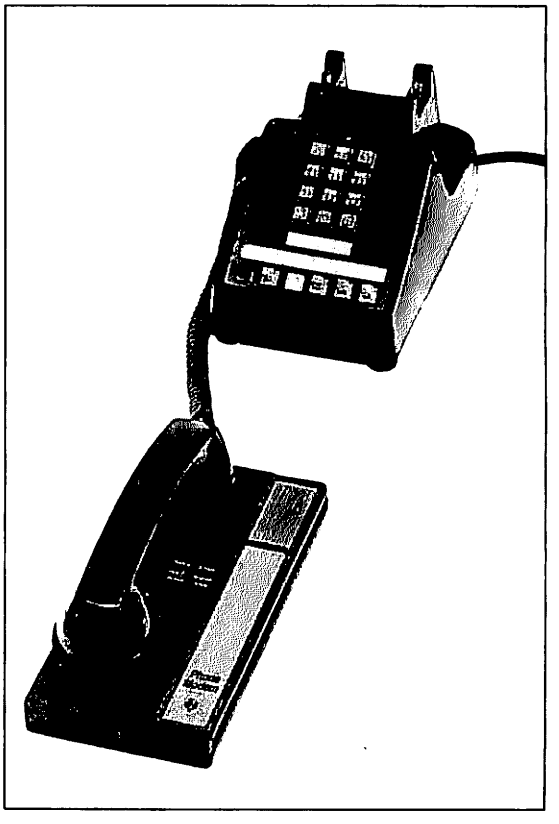
The TI 99/4 has enormous power available with 16K RAM; all of it can be used for programming. You can use up to 72K of memory at one time: 16K user RAM; 26K internal ROM (more than twice as much as the nearest competitor); and a 30K module. And unlike every other home computer, all its internal machinery—operating system, BASIC language, BASIC interpreter, sound and speech synthesis, and color graphics programming—is fixed inside the 26K ROM. With most other home computers, you have to use your available RAM memory to generate colors and sounds or add extra, expensive memory boards.

The 99/4's keyboard has 40 keys on a simplified typewriter-style keyboard. The shift key sets up second functions and commands. Its color video monitor displays 24 lines by 32 characters and creates 16 different colors. It has 32 sets of eight characters each with different foreground and background colors.

And TI packs all this versatility into a console that measures 10 inches by 15 inches by 2.5 inches, by far the smallest console of any American home computer.

SPEECH SYNTHESIZER

Texas Instruments incorporated its advanced sound and speech synthesis integrated circuitry into the 99/4. The console can produce five octaves and three simultaneous tones, while the sound controller chip can speak three voices with five-octave musical resolution.



Texas Instruments' new telephone modem peripheral. (Courtesy of Texas Instruments, Inc.)

TI offers a Solid State Speech® Synthesizer as a peripheral. It can speak, in just one module, up to 300 words, and it can be programmed. People who know TI BASIC language can teach the synthesizer to speak up to 800 more words as well. It has a plug-in vocabulary expansion, which accepts TI's plug-in vocabulary modules.

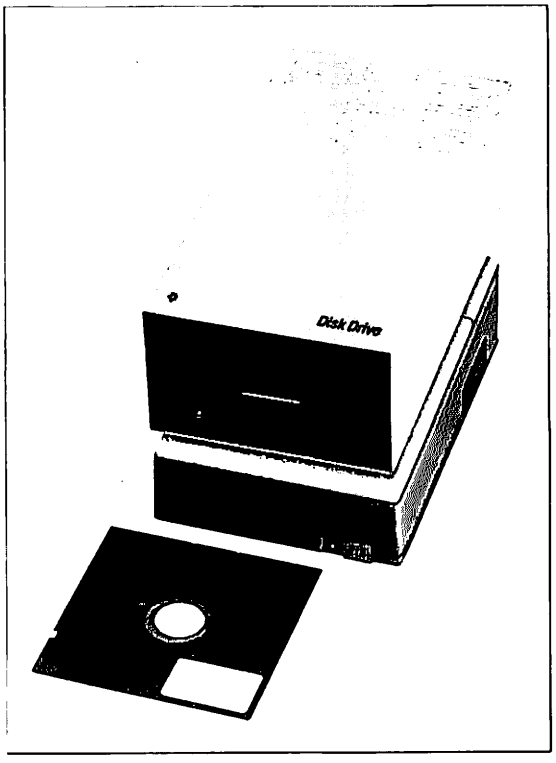
Other peripherals TI introduced in 1979 include two joysticklike controllers and an interface for a cassette tape recorder.

NEW PERIPHERALS

TI took a great leap forward in peripherals in 1980 when it simultaneously introduced four new pieces of additional equipment. They include a mini-floppy disk system with a controller for up to three drives, an acoustic telephone modem, a thermal printer, and an RS-232 interface.

MINI-FLOPPY DISK DRIVE — The floppy disk drive system, using 5¼-inch floppy disks, can store up to 90,000 bytes of information on 127 files on each mini-floppy disk. Its controller accepts either fixed or variable length records and sequential or relative files. TI provides a special Solid State Software command module, which includes disk and file maintenance commands. This module makes using disk drives much easier and saves several thousand bytes of space on each disk. The controller can operate up to three disk drives at one time through the command module. TI has priced the controller at $300 and each disk drive at $500.

ACOUSTIC TELEPHONE COUPLER MODEM — This TI 300-baud modem requires an RS-232 interface and connects to the 99/4 through on port. TI also provides a command module called a "terminal emulator," which makes the home computer work like an efficient home information terminal, but the modem works like any other modem. The command module costs $45; the modem, $225.



Texas Instruments' new mini-floppy disk drive. (Courtesy of Texas Instruments, Inc.)

THERMAL PRINTER — The TI thermal printer prints 32 columns of 5 × 7 dot-matrix characters at a speed of 30 characters per second. TI's BASIC controls the printer and can list programs from the 99/4 memory. Line spacing can be varied, and special characters can be defined in programs of your own design. The printer also has 32 graphic symbols for charts and graphs. It uses 3.5-inch thermal (or heat-sensitive) paper, like the paper used in some of TI's printing calculators. (Using a thermal printer makes the operation much quieter and more reliable than impact printers.) TI's suggested retail price for the printer is $400.

RS-232 INTERFACE — The RS-232 interface converts the 99/4's parallel data bus into a se-

rial output and makes it possible to connect the 99/4 to a host of RS-232-based printers, modems, terminals, and other computers. It can function at baud rates from 110 characters per second (cps) to 9,600 cps. TI's suggested retail price is $225.

EASE OF OPERATION

TI has made the 99/4 one of the easiest home computers to use. You slip in a command module and the 99/4 starts itself. Then you just follow instructions and answer simple questions. For example, most operations have simple three-step use: "1. Select 1 of the 4 decision areas. 2. Select the specific question you want answered. 3. Type in the information asked for, then press ENTER."

Say you want to evaluate buying a house. Using a home financial module, you'll choose a financial decision area called "Residence." After you get to a category called "Buy a House," the 99/4 instructs you to do the following:

"ENTER
"PURCHASE PRICE $80500.00
"DOWN PAYMENT $20000.00
"NUMBER OF YEARS FOR MORTGAGE REPAYMENT 25
"ANNUAL % INTEREST RATE ON MORTGAGE 10.25"

In a flash, the computer will make all these calculations, and display this: "Your payments will be: Monthly Mortgage Payment $560.46; Monthly Property Taxes $50.00; Monthly Insurance Payment $37.50; Total Monthly Payment $647.96; Press ENTER to Continue." And it will go farther and farther into appreciation, depreciation, resale prices, and much more.

All of TI's command modules work in similar, easy fashion. More than 20 command modules are now available, and TI plans to introduce many new ones each year. They range in price from $19.95 to $79.95. See the Appendix for a complete listing.

Bally Professional Arcade and Computer System

Bally Manufacturing Co., Consumer Products Division, 10750 West Grand Avenue, Franklin Park, IL 60131

In late 1979, Bally Manufacturing, the same company that makes electronic arcade games and slot machines and operates casinos, announced a Videocade and Computer System priced at $499, based on its popular Professional Arcade computerized video game. But it delayed introduction of the three-level Computer System while marketing its Professional Arcade under several names, one of which is Home Library Computer. The release date for the full Computer System remained uncertain in late 1980, but the outlines of the system had been made public.

Level I of the system was presented as a video console with a 24-key calculator keypad and two eight-way controllers. Based on a Zilog Z-80 microprocessor, it has a 12K ROM internal memory and up to 8K RAM capacity in each cassette. It also has a five-function calculator with ten memory slots and can generate up to 256 different colors on a TV screen. It, too, uses a keypad overlay that shows how to use its functions. Level I has a simple Bally BASIC language variation called Tiny BASIC.

It has five different cassette series: six action games, four sports games, three educational tutorials, a strategy game, and a programming cartridge.

Level II BASIC comes with a self-teaching programmer's course, an easy-to-use programming keypad, and a three-octave music synthesizer. It also has an audio cassette interface, which lets a user attach a cassette recorder and permanently store all of the simple programs he creates.

Level II, as the Bally Computer System, is already available.

Level III was said to add a 60-key typewriter keyboard and Grafix, an advanced and unique language. Planned peripherals included mini-

floppy disk drives, a printer, a telephone modem, dual audio cassettes, and an audio output.

The Bally Computer System has at least 17 games and program cassettes. See the Appendix for a complete listing.

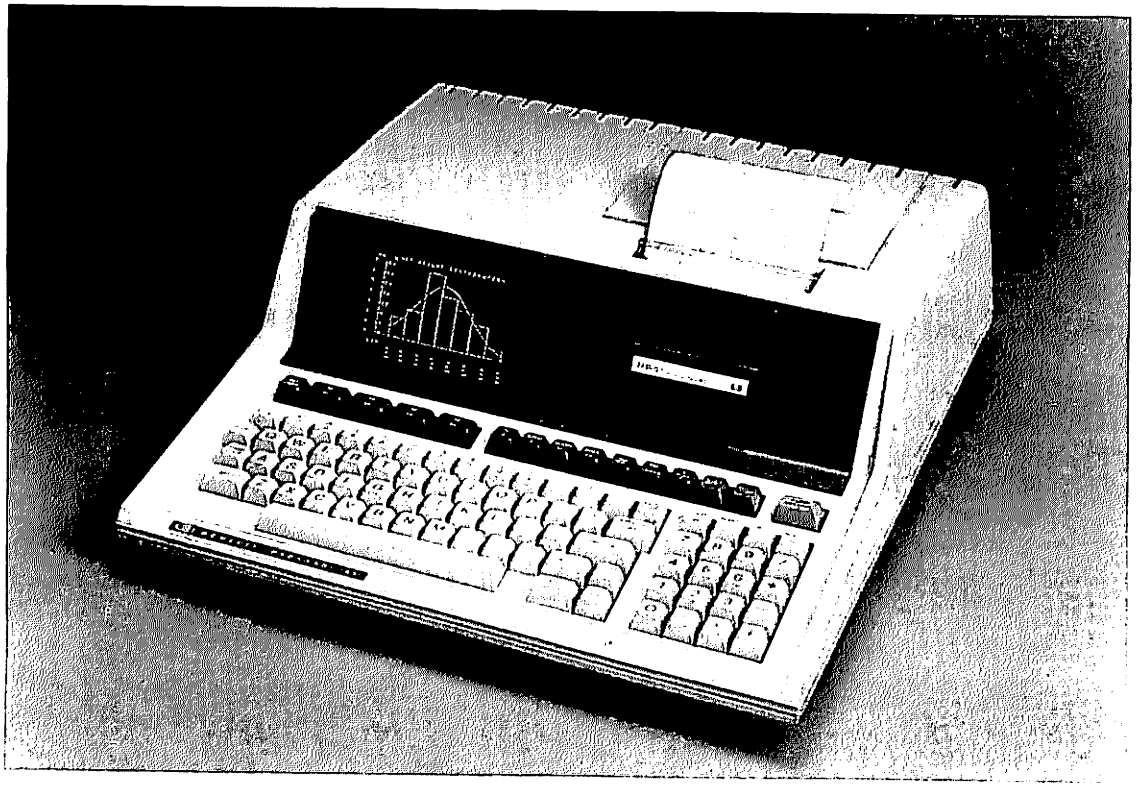
Hewlett-Packard HP-85 Personal Computer

Hewlett-Packard Company, Inquiries Manager, 1507 Page Mill Road, Palo Alto, CA 94304

Hewlett-Packard, one of Texas Instruments' top competitors in the calculator and business and industrial minicomputer fields, has carved its own niche in the world of personal computers. Its remarkable entry, the HP-85, is designed for professionals such as engineers, scientists, accountants. and investment analysts, but can be used equally well in the home by serious hobbyists with a knowledge of programming and in secondary schools, colleges, and universities to teach computing.

The compact computer—only 16 inches wide, 18 inches long, and 6 inches tall—contains a 16-bit microprocessor, a typewriterlike keyboard, a 5-inch CRT display screen, a thermal printer, a tape cartridge, and sophisticated graphics capability all in one unit. In addition to the keyboard, it has a 20-key number pad to made entering numbers and math problems simple and quick. And it can be programmed in an advanced BASIC language much like English.

Bally Professional Arcade and Computer System comes with two joysticks and a calculatorlike keypad. (Courtesy of Bally Manufacturing Co.)



The HP-85, the new professional and scientific personal computer from Hewlett-Packard Company, is a compact computer with a 16-bit microprocessor, a five-inch video display, and a thermal printer all in one lightweight unit. (Courtesy of Hewlett-Packard Company)

In addition, it has four input/output ports that accept graphics plotters, printers, disk drives, and other peripherals that Hewlett-Packard plans to introduce soon. The HP-85 comes with 16K RAM and can be expanded to 32K RAM simply by plugging an optional memory module into one of the four I/O ports.

Its display has a very high resolution for such a small (5-inch) screen. It can display 16 lines with 32 characters each, and the computer remembers 64 lines, so that a user can roll the display up or down with a scroll function. In the graphics mode, the small display has more than 49,000 distinct points (256 by 192 dot field) available for extremely high resolution plotting. Each point is .00001 inch in size. Users can plot information, such as large amounts of stocks and bonds information, with charts and graphs. They can discern business or market trends with a chart or graph instead of long numerical tables, and even better, they can save the charts and graphs with the thermal printer.

The HP-85 keyboard is divided into four types of functions: 1) letters, like those on a typewriter; 2) numbers on a separate keyboard for mathematical functions; 3) "soft" keys, which a user defines when he writes a program; and 4) display, editing, and control keys, which operate the display screen, the internal operating system, the cassette tape drive, and the printer.

The machine's tape drive uses HP Data Cartridges, which can hold up to 217,000 (217K) bytes, and it automatically set up a tape di-

rectory of programs and data on the tape. The system can automatically refer to this "table of contents" to locate a prerecorded program or information.

APPLICATIONS SOFTWARE

H-P, like Texas Instruments with its calculators, learned with its HP-67, 97, and 41 programmable calculators that most people want to follow instructions on prerecorded software packages. Hewlett-Packard has also transferred this lesson to its personal computer and offers at least seven cartridges with prerecorded programs. (See the Appendix for a complete listing of these applications packages.) The company has also provided manuals filled with dozens of programs developed by its own programmers and users' groups. These programs are written and must be entered into the HP-85 by hand. H-P has provided that many programs used in its desk-top minicomputers with BASIC languages can be adapted to the new HP-85.

Obviously, the HP-85 is a remarkable machine fit for professionals and people with a knowledge of programming. Its price is also high compared to the rest of the newest home computers. The machine sells for $3,250; the optional 16K byte expansion module for $395; and the application software packages for $95 each.

Although the HP-85 carries a high price tag, its self-contained, but enormous, power and versatility crammed into a portable, lightweight package are a good indication of where home computers are headed. We've reviewed seven of the newest home computers, from the tiny, inexpensive Sinclair microcomputer to the self-contained, portable HP-85. In between, we've seen the gamut of what home computers are like now.

But what about tomorrow? Rumors of new home computers from more giants (IBM or Burroughs), from more toy companies, or from Japan appear regularly in the computing trade press. And it's highly likely that between the time this manuscript was completed and its publication date, further developments more appealing than the Sinclair and more sophisticated than the HP-85 will have been announced.

The only constant in the home computing field is change, and no group of home computers better illustrates that maxim than the best-selling home computers. In the next chapter, we'll see how the "old men" of home computing have rapidly expanded and changed to meet ever-increasing demands from the public.

6. The Handiest Home Computers

MORE THAN HALF A DOZEN "plug in and go" home computers have been on the market for at least two years. Their manufacturers have rapidly responded to a very competitive environment by providing as much new equipment and as many new programs as possible, as fast as they perceived the public wanted them. More than 100 other computer companies either make peripherals or write software to support the burgeoning demand the computer manufacturers alone can't match. As a result, numerous variations, expansions, and configurations for each well-established home computer have appeared. For example, Radio Shack provides five different kinds of printers with prices ranging from a low of $219 to almost $3,000 for its TRS-80 line. In software, more than 2,000 programs have been written for the TRS-80. And each of the handiest home computers, from the Commodore PET to the Atari 400 and 800, is supported by its own "cottage industry," which supplies more equipment and software.

It would be almost impossible to describe all of these devices and programs; the task would require an encyclopedia, at least. But we can describe how each of the most popular computers has evolved during the past three years and highlight each one's most important features and peripherals. Throughout this chapter, the same format will be used to discuss each of nine home computers. First, an overall system description will be given; second, each machine's system memory and its expandability will be discussed; third, the most important peripherals will be described; and finally, each system's necessary software will be outlined.

As you go through this chapter, keep in mind one point: Do not compare the machines feature for feature, because each one differs in many subtle ways and has different operating requirements, which may rate differently according to each buyer's preferences. Furthermore, there are too many features altogether to explain in any one book. Prices, too, are subject to change.

Of course, you can tell whether you want a black and white or color capability, or prefer a self-contained unit or a modular one. But system efficiency, reliability, and software requirements will take more detailed study. Check the bibliography and read computer magazines when you are ready for this in-depth information.

Radio Shack TRS-80 Level I and II

Radio Shack, TRS-80, 1300 One Tandy Center, Fort Worth, TX 76102, or any one of 7,000 Radio Shack outlets and 50 computer centers near you.

Radio Shack has sold more than 200,000 of its TRS-80 personal computers and has spawned a huge cottage industry of newsletters, users' groups, clubs, software support companies, and peripheral equipment manufacturers. It has increased the TRS-80's vast popularity by multiplying the number of available models and peripherals. Radio Shack has provided a home computer for practically every price range, from its $499 Level I to its $8,737 Model II Deluxe 2 Business System. Regardless of the variations,

however, Radio Shack would not have succeeded with its TRS-80 without an easy-to-use and easy-to-understand computer. And that it has provided.

SYSTEM DESCRIPTION

The TRS-80 is the easiest to understand of any home computer. The silver-gray TRS-80 Level I consists of a keyboard and microprocessor unit, a standard cassette recorder, a 12-inch black and white video monitor, and a power supply. Each piece is separate, which makes the system modular and readily expandable.

The keyboard unit holds a Z-80 (Zilog) microprocessor and has a 53-key typewriter-style keyboard. The unit also has an output leading to the video monitor, an interface for the cassette recorder, and an important expansion connector.

The video screen can hold 16 lines of 64 letters and numbers (also called *alphanumeric characters*), and can generate 128-element by 48-element graphics on the screen. It displays only capital, or upper case, letters. The TRS-80

The man and woman in the office of a small business work with a simple TRS-80 Level I system. The keyboard and microprocessor are within the same unit; on the right, the cassette recorder; in the back, the video display monitor; and to the side of the monitor, the power supply. (*Courtesy of Radio Shack*)

Level II, which can be added to a Level I for $120, adds a "graphic character" set of 61 characters (256 by 144) with a resolution of about 39,000 screen elements.

The keyboard has seven extra keys, four of them arrow keys that move a cursor, and three command keys. The Level II adds several more functions for these seven keys. And the keyboard has a number keypad on the right side with digits 0–9 and an Enter key.

The Level I casssette recorder operates slowly at 250 baud, but Level II runs twice that fast at 500 baud. The recorder both accepts outputs from the processor and loads programs or information into the processor (but not at the same time).

The expansion connector in the back of the unit can accommodate a printer cable, a voice input or output device, or specific peripherals offered by other manufacturers.

SYSTEM MEMORY

Radio Shack offers four variations of its Level I and II machines based on language and memory: Level I with 4K RAM or 16K RAM memory; or Level II with 4K or 16K RAM memory. The "level" designation, by the way, describes two different BASIC language interpreters, each of which is fixed inside each model's ROM memory. Level I BASIC consists of a simplified computer language similar to Palo Alto Tiny BASIC. It is called "tiny" because it has limited abilities to handle information. Level II BASIC, written by Microsoft, has many advanced capabilities, including an editor that lets you change programs easily and many mathematical functions. A TRS-80 owner can learn programming on the Level I and upgrade to a Level II and learn more advanced programming. Any Radio Shack center will upgrade a Level I machine to Level II by replacing the ROM integrated circuits within the keyboard/processor unit for about $120.

SYSTEM PERIPHERALS

Although designed as a self-contained home computer, the TRS-80's modular design incorporates a required expansion interface and many peripherals with little trouble. Most peripherals, however, require the Level II 16K model to operate.

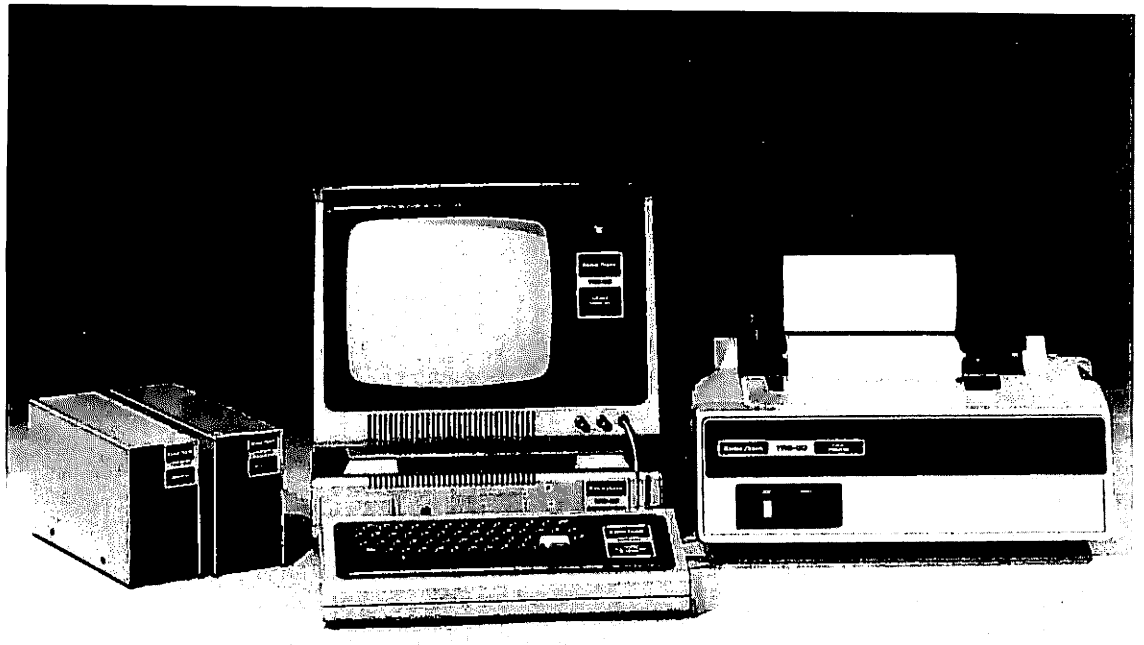
The $300 expansion interface sits directly beneath the video monitor in a plastic box designed for it. It provides connections for printers, disk storage drives, a second cassette recorder, and an RS-232 I/O port for equipment made by other companies. And the expansion interface can accept up to 32K more RAM for a total of 48K RAM, making a very powerful home computer.

Remember one thing, however: if you use the RS-232 port and add a peripheral, you may need a special program to run it.

The most popular peripherals that TRS-80 owners add to their basic systems include disk drives and printers.

DISK DRIVES AND TRSDOS — Radio Shack's Mini-Disk uses standard five-inch diskettes, each of which holds up to 86,600 bytes per disk. Up to four disks can be added to the expanded Level II system. When you buy the first disk, however, you get the necessary disk operating system, called TRSDOS, and Disk BASIC language. Both have been recorded on a diskette that comes with the drive. The TRSDOS and language take up about 39,000 bytes, leaving 50,000 bytes of free storage space on the first diskette. But the advantage is that the TRSDOS and BASIC programs will operate up to four drives, leaving the second, third, and fourth drives completely free for storage.

FIVE PRINTERS — Radio Shack offers five different printers, including an inexpensive Quick Printer II ($219), which uses aluminum-coated roll paper and prints up to 32 characters per line. Quick Printer I ($499), using the same kind of paper, prints 150 lines a minute, upper and lower case letters, and has other advanced features. Others include a Line Printer II (about



A TRS-80 32K system with two Mini-Disk drives and its Line Printer II, illustrating the variety of peripherals available. The video monitor rests on top of the TRS-80 Interface Box. (Courtesy of Radio Shack)

$1,000), which prints 50 characters per second on eight-inch wide paper with 80-character columns; the remaining two are large and expensive business printers.

All five use the same printing method: a dot matrix in which each character is formed from separate dots. (Regular typewriters are called impact printers, because they print by striking each letter as a whole, at one stroke.)

Other popular peripherals include: a voice synthesizer through which a user teaches the computer to speak by typing in word combinations; the VOXBOX® or voice recognition device, which can recognize up to 32 spoken words; and a Telephone Interface II, a full "answer/originate" acoustic coupler modem. Most of the available peripherals require one or more of the following: the expansion interface, Level II, and connector cables. Make sure you ask about these necessary devices before you buy.

SYSTEM SOFTWARE

As we have noted, Level I comes with a limited tiny BASIC language, but it does have some graphics capability, data storage within the program, and some use of *strings*—that is, information considered to be data-treated strings of characters without regard to their number and value. Most important, Level I's user manual provides an excellent explanation for using the TRS-80 and learning BASIC language programming.

Radio Shack itself provides more than 55 different programs, 21 of which are for business use. The rest are mostly games, educational, and personal management and computer language programs. (See the Appendix for a com-

plete list.) In addition, during the past three years, thousands of programs have been written for the TRS-80; many can be bought in stores, and many others have been published in newsletters and magazines.

SYSTEM PRICES

The TRS-80 Level I with 4K costs $499; its 16K Level I big brother, $729. The 16K Level II costs $849. Among the peripherals, the Expansion Interface costs from $299 to $597; the voice synthesizer, $399; VOXBOX,® $170; the telephone interface, $199; and the mini-disk drives, $499 each. A 32K Business System, which costs $3,294, includes the 16K Level II, the expansion interface, two mini-disk drives and Line Printer II. Radio Shack also offer three other packages for business and professional uses based on its Level II system.

Commodore PET Personal Computer

Commodore Business Machines, Inc., 901 California Avenue, Palo Alto, CA 94393, or any of hundreds of computer stores.

The Commodore PET has been the most popular self-contained home computer for more than three years. Originally the PET (or Personal Electronic Transactor) had a small screen and an odd keyboard, but provided several unique characteristics that made it easier to operate than many other home computers. Although the keyboard had a typewriter format, the keys were styled like those on a calculator and were jammed close together in a rectangle. They were difficult to use for touch typing.

Commodore has cured that problem with its new PET 2001 Series, which has a full typewriter keyboard while keeping all of its original unique capabilities. The first version is still available, too, and is reasonably priced.

SYSTEM DESCRIPTION

The basic PET has its nine-inch black and white video screen mounted on top of the keyboard and cassette module; it is 16½ inches wide, 18½ inches deep, and 14 inches high. Its cassette storage medium is built in and its power supply is inside the module. The unit uses the MOS Technology (a Commodore sub-

The video screen displays Personal Software's Microchess program, the first program to sell 50,000 copies, as an example of the graphics and displays a buyer can get with a TRS-80 Level I. (Courtesy of Personal Software)

sidiary) 6502 microprocessor and has either a 73-key calculator-type keyboard or the new typewriterlike keyboard.

The video display has a 25-line by 40-character resolution, and internal software provides a blinking cursor control, automatic scrolling, and four cursor commands.

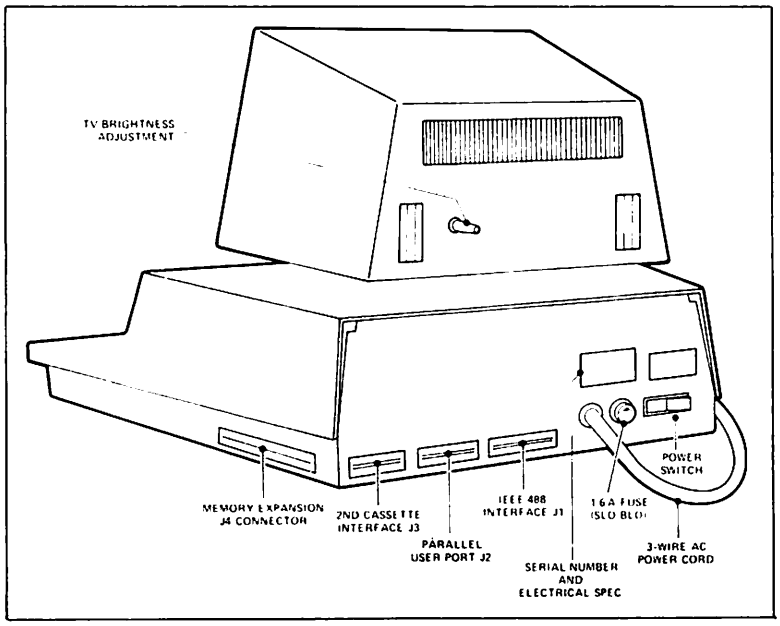
The standard set of letters and numbers includes 64 alphanumerics and command characters, 64 unique characters, and lower case letters. All the characters can be reversed on the screen with an RVS key, in effect doubling the number of available characters to 256.

Among the PET's unique keys are a RUN/STOP key, which allows a user to interrupt a running program, and a (RUN) key for loading and automatically executing programs from a cassette. A group of six cursor control keys allows a user to directly edit a line in a program rather than use text editor commands. This ability makes editing long programs much faster and easier.

The special graphics characters can be combined in an incredible variety of forms and shapes, and allow beginners to create and play with computer graphics from the first day.

The PET has four connectors on the main

The new PET 2001 Series with a full typewriterlike keyboard and a number/command pad on the right. Compare this keyboard to the original PET illustrated in Chapter 3. (Courtesy of Commodore, Inc.)



The rear view of the PET 2001 shows the switch, fuse, cord, and interface connectors and ports. (Courtesy of Commodore, Inc.)

board, a large number for a basic unit, and provides an interface for a second cassette drive, an I/O port, a standard (IEEE-488) interface port, and a connector for its address, data, and control buses. These connectors make adding peripherals and expanded memory to the PET much easier and less expensive than most other home computers.

SYSTEM MEMORY

The PET has 8K RAM memory, but makes up for an only average amount with a powerful 14K ROM BASIC interpreter. The PET can be expanded up to 32K RAM in its 2001 Series and business-oriented computers.

Its BASIC language was written by Microsoft, and users can learn it very easily.

The PET also has a 1K ROM video screen memory to direct the screen's operations, and 2K ROM of I/O memory that controls, separately from the other ROM, all inputs and outputs with the operating system.

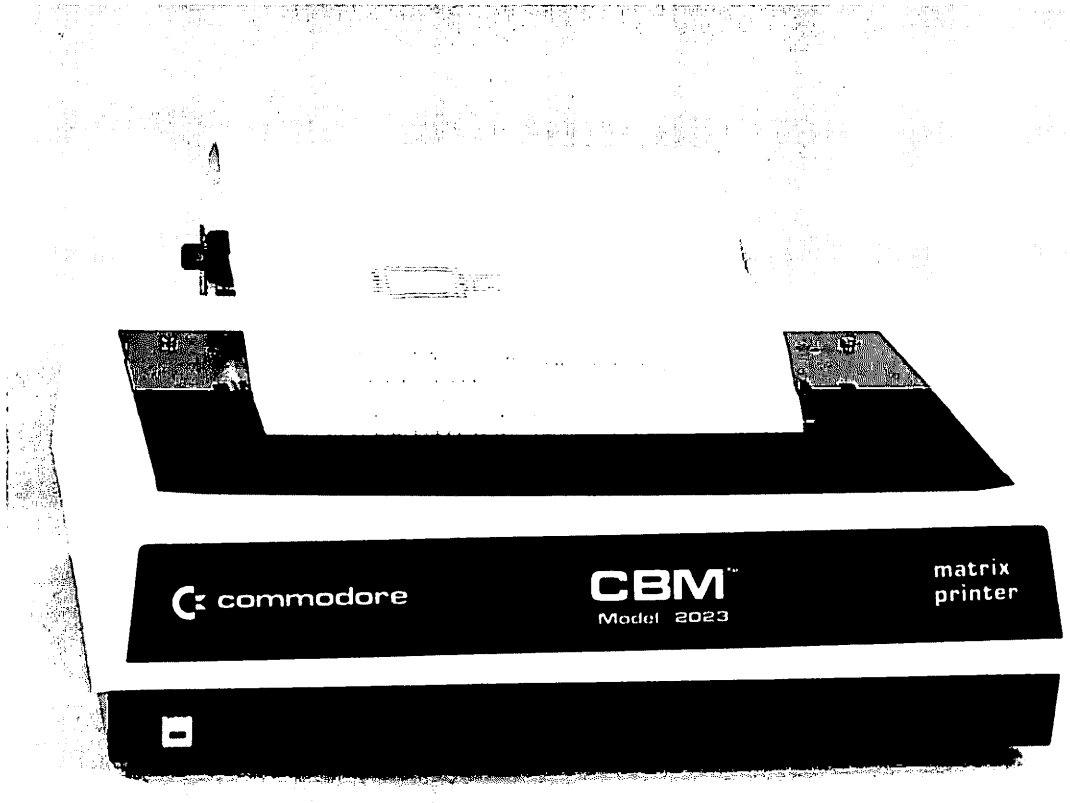
SYSTEM PERIPHERALS

For several years, computer experts criticized Commodore for leaving peripherals to other manufacturers. Toward the end of 1979, for example, Commodore did not have its own printer. Its PET Plus model did come with a second cassette recorder, but that was all. But many other companies' printers, modems, and disk drives could be attached to the PET through its standard IEEE-488 interface.

Commodore has completely changed that situation. In recent months, it has introduced a dual floppy disk drive, a friction-feed matrix printer, and two tractor-feed printers. These peripherals are aimed mainly at small business customers. PET also introduced an 80-character, 12-inch cathode ray tube (CRT) video display monitor in late 1980. And Commodore's management announced a new policy to market PETs and its new business series aggressively, with more peripherals and software support in the future.

SYSTEM SOFTWARE

PET software documentation has also been criticized in the past, but Commodore has published new manuals and has begun providing



Commodore's new model 2023 dot matrix impact printer, another example of PET's aggressive new stance in the home computer industry.

more dealer training and support to help new owners hook up peripherals.

Commodore has also introduced more than 100 new software programs, most of them for small businesses. Of course, as the second largest-selling home computer, the PET has had hundreds of cassette tape programs developed by many software companies. Look in the Appendix for those houses that provide their programs in PET versions.

In mid-1980 Commodore introduced two new peripherals: a million-byte (megabyte) double-density, dual floppy disk drive and a telephone modem interface.

The PET has proved very popular in unusual applications, ranging from industrial process controls to security alarm systems to sophisticated chess programs and black and white graphics.

SYSTEM PRICES

The simplest PET with 8K RAM costs $795, with a 16K version at $995 and a 32K version at $1,195. The new peripherals are priced competitively.

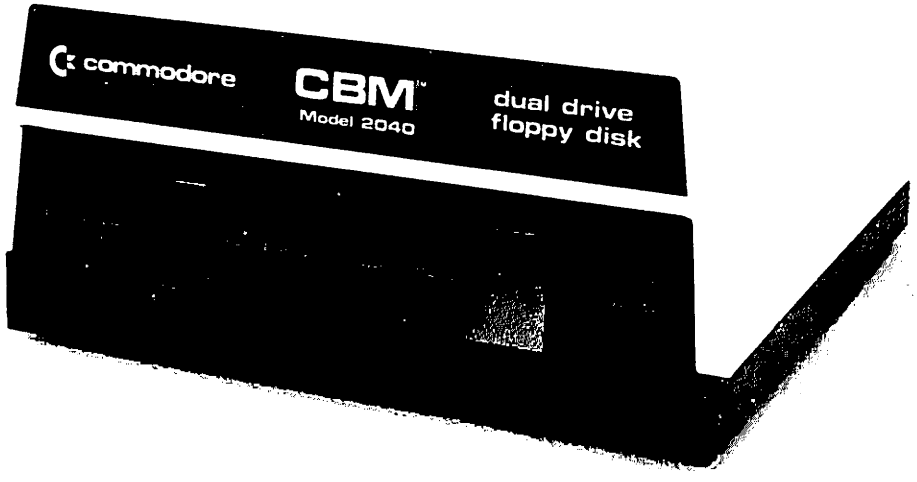
Apple II Plus Personal Computer and Apple III

Apple Computer, Inc., 10260 Bandley Drive, Cupertino, CA 95014, or any of more than 650 dealers worldwide.

Apple Computer didn't stop after its success with its Apple II model. The company, which had signed an agreement with ITT to manufacture and market home computers in Europe, upgraded its computer and introduced the Apple II Plus in 1979. The Apple II Plus version incorporated a more sophisticated, yet easier to use, BASIC language, called Applesoft, and an exclusive "Auto-Start," which runs programs automatically when you turn the computer on. The market-wise company added these features at no extra cost to the buyer.

Then, in mid-1980, Apple stunned the personal computing industry, practically abandoning the home computer field by introducing its Apple III, a highly sophisticated and powerful personal computer. Packaged as a systems solution for education, small busness, science, and industry, the Apple III includes an 80-character by 30-line color video monitor, an expanded keyboard, twice as much RAM memory—32K RAM expandable to 128K RAM—dual minifloppy disks, four parallel input/output ports, one serial I/O port, and expanded graphics capability.

Compared to the Apple II, the Apple III is, as



Commodore's new Model 2040 Dual Floppy Disk Drive.

company officials have said, "everything the II should have been but wasn't."

Apple III also includes an internal ROM language system, so that users don't have to load BASIC from disks, and—most important for current Apple II owners—an "emulator" program, which allows programs for the Apple II to run on the new machine.

The new keyboard has more versatile capabilities and far fewer command keys than the II. It comes with a numeric keypad on the right side, four cursor keys, upper and lower case shift, and more keys for expanded graphics.

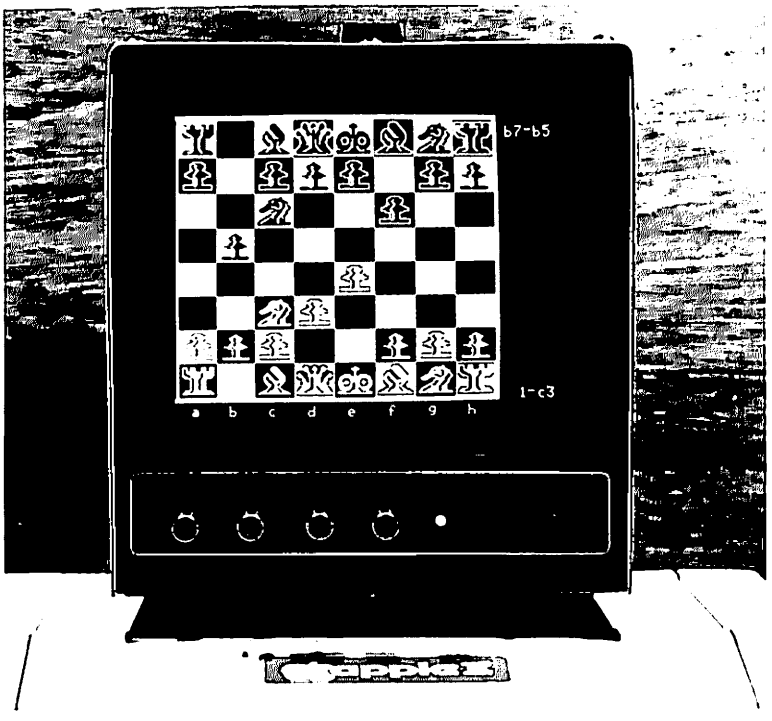
Apple officials say that they designed the new III machine for serious personal computer users because Radio Shack, Texas Instruments, Atari, and others were willing to do the total marketing necessary to make home computers acceptable to a mass market. But Apple discovered that its best markets were in four areas—those that showed the most potential for sophisticated microcomputers: education (schools and colleges), science, industry, and small business: "We found buyers were using the Apple II on everything from oil rigs to the Space Shuttle." Thus, Apple has prepared four software packages for the new model: word processing; professional/manager helper; science/engineering; and an industrial development system.

The Apple III, packed with power and peripherals, will be expensive, with prices ranging from $3,400 to $7,800. Regardless of the price, anyone interested in serious personal computing should take a close look at the new model. The company has an excellent and well-deserved reputation for versatile, powerful products that remain one step ahead of the industry.

SYSTEM DESCRIPTION (APPLE II PLUS)

The Apple II Plus, based on the 6502 micro-

The Apple II Plus with all the trimmings—the many peripherals that hook directly to the Apple for a wide variety of uses: mini-floppy disk drive; telephone modem; printer; video monitor; Apple Graphics Tablet; microphone for voice recognition; and several expansion modules. (Courtesy of Apple Computer, Inc.)



The Personal Software Microchess Program, illustrated earlier in this chapter, here demonstrates the extraordinarily good resolution you get with the Apple II Plus. The chess program can be run in any of 15 colors and provides a vivid and exciting game. (Courtesy of Personal Software)

processor, has a standard 53-key typewriterlike keyboard, hand controls (joysticks) for game-playing, a sound capability for music and speech synthesis, and an impressive graphics capability. The basic system comes with an inexpensive cassette tape recorder, but most Apple owners quickly move to its floppy disk system.

Although Apple buyers must provide a video monitor, Apple's impressive color graphics virtually dictate that an owner use a color TV or color monitor. The Apple has 15 standard colors in an 1,880-point array and a high-resolution array of 54,000 points with which users can create finely detailed pictures or designs.

The keyboard unit has built-in loudspeaker that prompts a user for inputs, warns of errors, and allows a user to create synthesized music without a peripheral interface. The unit also has eight I/O accessory ports, through which users can hook up a variety of peripherals. This is exceeded only by Radio Shack's selection.

SYSTEM MEMORY

The basic Apple II Plus comes with 16K RAM memory and 12K internal ROM. It can be expanded to 32K RAM and 48K RAM versions. A buyer must add a RAM Expansion Memory Module, which contains 8K RAM devices, installation instructions, and a test program.

The Apple II Plus Auto-Start ROM card comes as standard memory. With the Apple Disk II, it automatically runs a disk when the system is turned on, and it automatically starts up in BASIC language without a disk system. Most important for beginners, it reduces the number of keystrokes for on-screen editing by up to 90 percent. The Auto-Start card replaces a standard ROM in the regular Apple II.

Auto-Start can also control a special Language Card, which allows Apple users to take advantage of an advanced computer language called PASCAL in addition to Applesoft BASIC. The Language Card has 16K bytes of

RAM and electrically takes the place of ROM memory. The Auto-Start automatically loads the language of the user's choice and protects both RAM card and internal ROM from change or damage. The Language System also includes diskettes for the Apple Disk Operating System (DOS), a language selection program, PASCAL, Applesoft BASIC, another language variation, Integer BASIC, and reference manuals for all three languages.

SYSTEM PERIPHERALS

Apple's strength has been in its wide variety of peripherals, which practically run themselves because Apple has included control programs with each one. The selection includes a popular Disk II floppy disk system, two printers and a printer interface card, a serial interface card for computer-to-computer "conversations," a Modem IIB and a communications interface card, and a sophisticated graphics tablet that lets a user draw on a video screen in seven colors at the flick of a wrist.

DISK II SYSTEM — This system has a powerful DOS, which contains a BASIC program that links disk programs together and allows users to name each file stored on the disk. It can hold up to 116K bytes on standard diskettes on 35 tracks. And it doesn't need its own power supply; the Apple II Plus can run up to 14 disk drives. Also, the drive controller can run either one or two drives at a time.

CENTRONICS PRINTERS — Apple sells as its printers two Centronics models: Printer IIA, a Centronics 779, which prints 132-dot matrix characters per line at 60 characters per second and can reproduce the 64-character, upper and lower case standard keyset; and the Printer II, a Centronics Microprinter-Pi. The latter can print up to 80 characters per line at 150 lines per minute, prints a full 96-character key set, and requires 3¾-inch, aluminum-coated paper. Each printer comes with a parallel printer interface card, a cable and connector, and an operating system documentation. Or the interfaces can be purchased separately to allow an Apple user to hook up the printer of his choice.

SERIAL INTERFACE CARD — This card allows the Apple to send or receive up to 30 characters per second from another computer, permits BASIC control of high-speed printers, and can be easily programmed with simple switches.

MODEM IIB AND COMMUNICATIONS INTERFACE — The package consists of a standard modem and a communications interface card. The modem can transfer information at either 10 or 30 characters per second. The communications interface includes its own control programs, so that users don't have to learn or buy programs and can easily control it with simple BASIC commands. Its interface is a standard RS-232.

APPLE TABLET — The graphics tablet provides unique ways to simplify drawings, maps, photos, histograms, schematic designs, architectural drawings, artists' sketches, and many other kinds of drawings and artwork. With a stylus, a user traces lines or shapes across the tablet; the tablet instantly picks up electrical signals, converts them into digital signals, and displays them on a video screen. A user can select from a "menu" on the tablet overlay the kind of marks he or she wishes to make.

The tablet's high resolution allows for 200 points per square inch and produces up to seven colors at a time.

All tablet functions are supported from BASIC language, and a user can store the illustration or design in memory. He can then instantly call up on the screen, or on a line printer, the finished draft. He can also store a number of illustrations in memory and call them up as they're needed.

Other peripherals include a voice recognition device, a speech synthesizer, and a music synthesizer.

SYSTEM SOFTWARE

Perhaps Apple's greatest strength has been its recognition that its machine can be best used when it is supported by plenty of system software. Apple's standard language is Integer BASIC, and Apple advises its beginners to learn this language thoroughly before advancing to its APPLESOFT and PASCAL advanced languages.

In addition to normal BASIC, the Integer version includes these features:

Immediate error indicator
Graphics commands set display from BASIC
Immediate execution of most statements
Ability to switch assignments among its I/O devices

Apple also provides a Utility Pack for its disk drive system, which contains an updated Disk Operating System (DOS 3.2 Update), an ability to chain APPLESOFT programs together, and a 170-page user manual.

Apple Programmer's Aid #1 provides a ROM-based library of routines, which enhance and simplify Integer BASIC programs and allow a user to generate five musical octaves and high-resolution graphics. The Aid comes as one 2K byte ROM chip, which a user slips into the machine.

The powerful APPLESOFT II Floating Point BASIC has ideal capabilities for home businesses and other advanced uses. It requires a 32K RAM, disk-based system, but you can use tape, disk, or plug-in cards to run it. Its most advanced software package is APPLE PASCAL®, and it provides a text editor, a compiler, a relocatable assembler language, and several system utilities (such as a desk calculator), but the PASCAL system requires 48K RAM with a disk drive and a language card.

At this time, Apple provides the most comprehensive software systems available for any home computer, but most of their features require a good knowledge of programming. However, the Apple system is modular and you can add to it as you learn.

SYSTEM PRICES

The basic Apple II Plus costs $1,195 in 16K RAM; $1,345 in 32K RAM; and $1,495 for 48K RAM. The Disk II system with drive and controller costs $595; Printer IIA, $1,545, and II, $695; Modem IIB and Interface, $390; and Graphics Tablet, $795. System software and firmware cards cost: $200 for the APPLESOFT II with Auto-Start ROM; $225 for a Centronics printer interface; $195 for a serial interface card; $200 for an Integer BASIC firmware card; $495 for the PASCAL Language System; and $180 for a parallel printer interface.

With its extraordinary versatility and its excellent color resolution, the Apple II has consistently appealed to people who don't mind spending a little extra for a lot of power.

Ohio Scientific Challenger Series

Ohio Scientific, 1333 South Chillicothe Road, Aurora, OH 44202, or any of hundreds of stores and dealers nationwide.

Ohio Scientific Instruments has consistently had firsts in home computing, not the least of which is the first and only woman president of a personal computing company. Charity Engel Cheiky manages a growing business that produces 350 items, from Etch-a-Sketch to small, single-board home computers. Other OSI firsts include the first fully assembled microcomputer—the original Challenger—and the first full dual floppy disk system.

Ohio Scientific has maintained its technical and scientific competence by offering a product line that ranges from an inexpensive single-board computer, the OSI 610, to a full-fledged data processing system that can work with 15 terminals. In between, Ohio Scientific offers its two new home computers, one of which is aptly called the Home Computer of the Future. In the following pages we will discuss Ohio Scientific's two most recent home computers and briefly review its full line.

SYSTEM DESCRIPTION

The Home Computer of the Future—C8P DF—became the first home computer to include an interface for a home control system. Through this interface, an owner can turn all the house lights off and on automatically and operate wireless home security systems, including smoke detectors, door contact switches, and an automobile burglar alarm. The C8P DF can also automatically notify a local police or fire department with an optional voice I/O system. Even better, by adding a Universal Telephone Interface, the computer can dial any telephone number with either dial or touch-tone telephones and also answer the phone. The computer includes all the needed interfaces and memory to execute all of these home controls; with other home computers, you have to add separate interfaces as well as the actual peripherals, such as smoke alarms.

The C8P DF system includes a full 53-key standard keyboard, BASIC language, a 2,048-character, 16-color video display, high-resolution graphics, sound output, a voice and music converter, joystick interfaces, two eight-inch floppy disks, and the home control interface.

Based on the MOS Technology 6502 microprocessor, the C8P computer can run more than twice as fast as many other home computers. Its display offers 32 rows of 64 characters with upper and lower case letters. Its 16 colors, including black, can be displayed in letters, numbers, and background.

Its basic I/O device is either a cassette recorder or a disk drive, both of which a buyer must add to the basic C8P system. The large floppy drive comes with the special C8P DF package.

What makes the C8P DF (and its smaller brother, C4P MF) unique lies in the number of I/O ports. Within the standard system, the C8P has eight ports and the interfaces for a printer, a modem, home security devices, remote control, joysticks, and an accessory bus interface for up to 48K RAM memory boards.

The main difference between the C8P DF and the C4P MF is simply the number of available ports and standard peripherals. The C4P MF has four I/O slots with one open slot for expansion, compared to the other's five expansion ports. The MF model comes with one mini-floppy disk, while the DF comes with dual eight-inch floppy disk drives with eight times the memory capacity.

The standard versions, called the C8P and C4P (for Challenger 8-Port and Challenger 4-Port, respectively), do not include the disk drives, the home security interface, and the maximum available memory. They do have all other features, including the high-resolution color graphics. For all four versions, a buyer must purchase his own color TV monitor, and, for the basic models, the cassette recorder.

SYSTEM MEMORY

The C8P DF comes with 32K RAM and 35.5K internal ROM and display ROM, and it can be expanded to 48K RAM. The basic C8P and C4P models come with 8K RAM and 19.5K internal and display ROM.

The simpler models include BASIC language in their ROMs, but the advanced models provide BASIC on disks or cassettes and use the internal ROM for needed internal operating systems, which run the additional interfaces.

The C4P MF can be expanded to 48K with dual mini-floppy disk drives. It also includes disk-based software with an information management system, a library of program development tools, and a large library of games, educational programs, and personal financial aids.

Ohio Scientific has recently introduced several software packages, including PASCAL, APL (another advanced language), and other computer languages.

SYSTEM PERIPHERALS

Ohio Scientific offers an extraordinary range of peripheral and interface boards (or cards, as they're also known) to go with its wide range of models or variations. Peripherals include a remote control package, a home security package,

a telephone modem, two joysticks, a universal telephone interface with a modem, a Votrax voice module for speech synthesis, three printers, and a special microprocessor for its advanced C4P and C8P models.

REMOTE CONTROL PACKAGE — This package includes a remote control console, two electric lamp modules, two electric appliance modules, and a home control operating system.

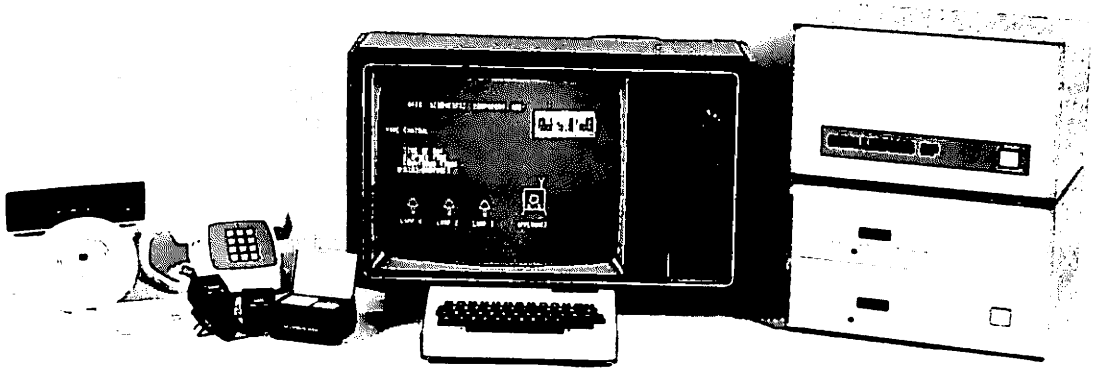
HOME SECURITY PACKAGE — It includes a console, a starter set, a fire detector, two window and one door security devices, and demonstration software.

TELEPHONE MODEM — This is a standard 300-baud modem, which can answer and originate calls.

UNIVERSAL INTERFACE — It includes an encoder/decoder for touch-tone phones, the standard modem, and a dial phone signal receiver/transmitter.

VOTRAX VOICE MODULE — This goes with the universal telephone interface so that the computer can generate voice responses to telephone calls.

PRINTERS — The printers include a low-cost printer that uses 8½-inch aluminum-coated



The Ohio Scientific Challenger C8P DF, "the home computer of the future," displays its Home Control program. Shown with it are (from left to right) a smoke detector, a digital telephone for automatic dialing, a light and appliance control command console, and standard eight-inch dual floppy disk drive. (Courtesy of Ohio Scientific, Inc.)

paper in a dot-matrix format; a Centronics 799, 110-character-per-second "business" tractor feed printer; and an inexpensive letter-quality printer from NEC Spinwriter.

6502C MICROPROCESSOR — For its advanced models, only Ohio Scientific can install a very high speed microprocessor that runs at least four times as fast as any other home computer. That means it can execute 1.2 million digital instructions per second.

SYSTEM SOFTWARE

The standard Challenger BASIC language is a Microsoft BASIC with random or sequential files and graphics. The two advanced models incorporate a special Home Control I operating system. Ohio Scientific provides a wide range of educational, game, business, personal management, and language utility programs on cassettes or disks. See the Appendix for a list.

OTHER HARDWARE SYSTEMS

Ohio Scientific continues to offer its Challenger C1P and C2P computers in standard or upgraded versions. The C1P models offer either 4K RAM or 12K RAM, and 14K or 32K RAM, with maximum RAMs of 8K and 32K respectively. Buyers can add, as peripherals, minifloppy disks, printers, or modems, and with the C1P MF, a remote control interface. Their displays are limited to 30 characters by 30 lines in black and white only.

SYSTEM PRICES

The complete C8P DF system costs $2,597; the standard C8P, only $985; while the advanced C4P MF model costs $1,695, and the regular model, $698. The C1P and C1P MF cost $349 and $995 respectively, very reasonable prices for small machines.

Peripherals prices include: $199 for the modem; $175 for the remote control starter set; $249 for the home security set; $499 for the universal telephone interface and modem ($799 including the Votrax voice module); and $695 for the small printer, $1,250 for the Centronics printer, and $2,795 for the Spinwriter.

NEW DEVELOPMENTS

Ohio Scientific has been working on two 16-bit microprocessors for more than two years. The company has announced that it plans to offer a processor with the Z8000 and Motorola 68000 16-bit expansion for its business-oriented Challenger III Series soon. We have noted the recently introduced software languages, but OSI has indicated others are under development, too.

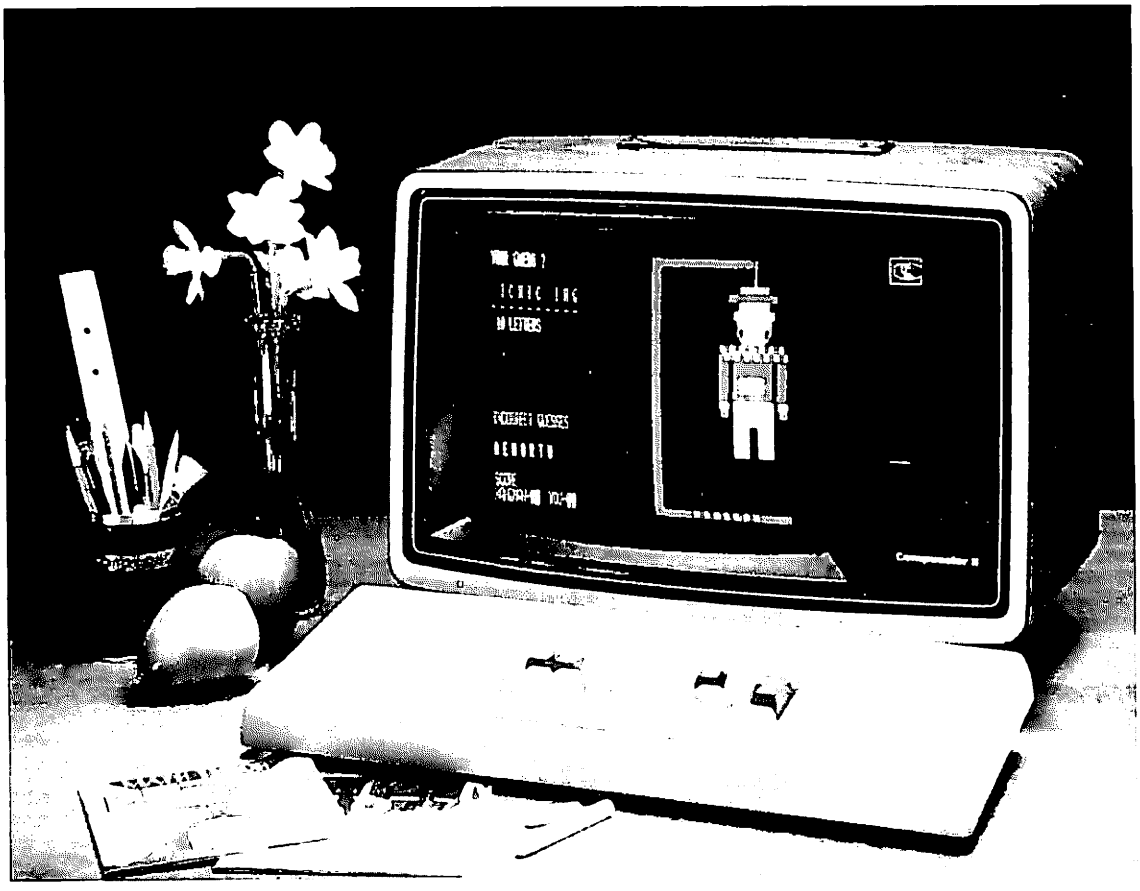
On a more simplified level, Ohio Scientific has also begun selling a new "Jungle Board" to replace five boards inside the standard machines, an ultra-fast 48K RAM memory board that uses less power than the old 16K RAM board, and a different, very low-priced 48K RAM board that should be the workhorse of the microcomputer industry.

Clearly, Ohio Scientific has staked out an important and enduring position in the home computer field with its wide product variety and its commitment to completing advanced research projects first.

Compucolor II, The Renaissance Machine

Compucolor Corporation, Box 569, Norcross, GA 30071, or any of hundreds of dealers.

Compucolor is the brainchild of an established manufacturer of terminals and microcomputers for industry, Intelligent Systems Corp. Intelligent Systems was one of the first to recognize what wide appeal attractive color graphics would have to people used to watching color television. Thus, it was the first home computer company to include a color TV monitor and a built-in disk storage system with its unit at a reasonable price. The company also introduced three different kinds of keyboards with between 73 and 117 keys.



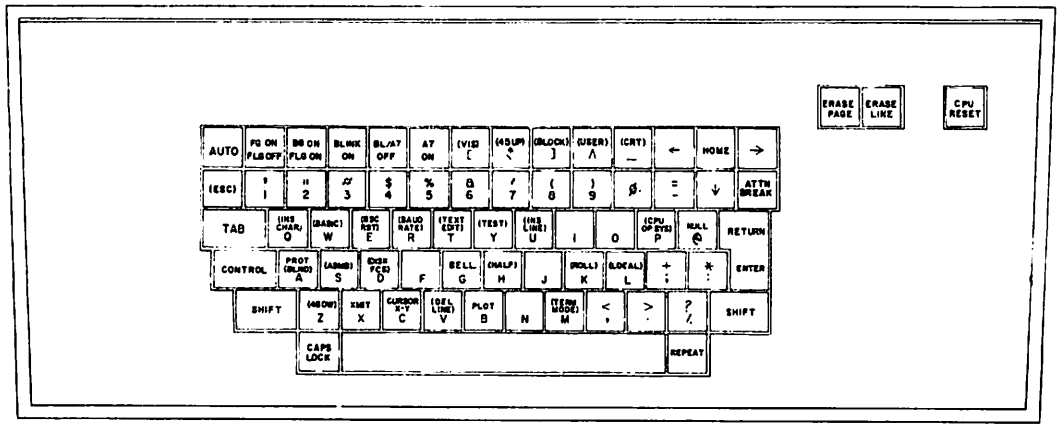
The Compucolor II Renaissance Machine displays a vivid word game, Hangman, on its large video monitor with a built-in mini-floppy disk drive and its large keyboard. (Courtesy of Compucolor Corporation)

SYSTEM DESCRIPTION

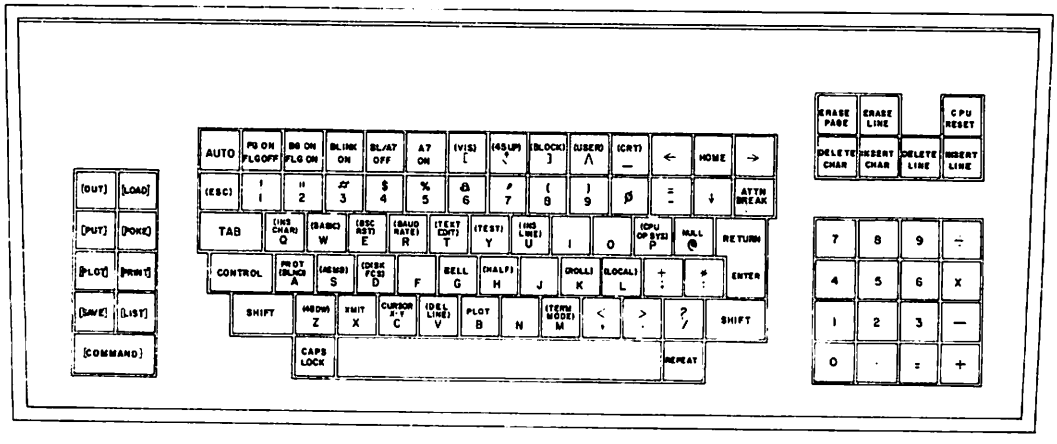
The Renaissance Machine has only two components, a large 13-inch color monitor, that has a mini-floppy disk drive built in, and a keyboard and processor unit. The convenient standard keyboard comes with 71 keys, and the internal processor is an 8080A CPU. The Expanded Keyboard with 101 keys includes color and number pads, with color keys on the left and number keys on the right. The color keys also serve as frequently used command keys. The Deluxe Keyboard, with 117 keys, adds 16 function keys which speed up the color graphics tremendously. The keyboard, though similar to a typewriter's, is compact, because most of the electronics have been placed inside the unique video monitor that General Electric Corp. specially designed for Intelligent Systems.

The unique monitor includes a micro-floppy disk drive in a disk compartment on the right side and, perhaps more unusual, contains most of the electronic components. The disk drive uses diskettes with 40 tracks and accepts up to 41,000 bytes on each side; the drive is dual-sided, another unusual feature not found on most home computers. The use of the disk has been made very easy with a one-button start-up:

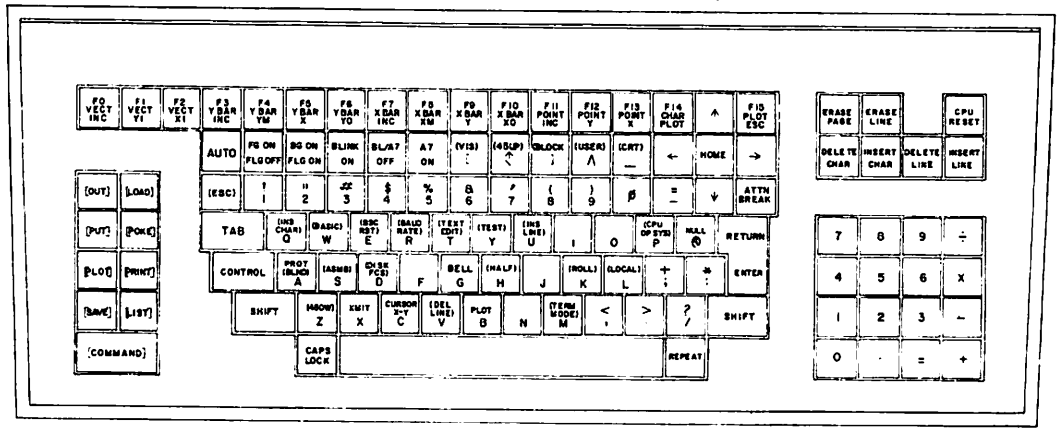
STANDARD



EXTENDED (Optional)



DELUXE (Optional)



the user slips in a program disk and presses the Auto button, and the program loads within seconds.

The CRT display has eight very high resolution colors. It has 32 lines of 64 characters each, or 2,048 characters. The machine can make two different character sizes and provides 64 standard characters and 64 special graphics characters. The graphics resolution is excellent, with 384 by 256 points, or 98,304 points available on the screen.

The unit comes with a telephone modem plug and a 50-pin bus for additional peripherals, and, like a TV, it has video control knobs for color and horizontal adjustments.

SYSTEM MEMORY

The Compucolor II comes in three models (and any model can accept any of the three keyboards): Model 3, with 8K user RAM; Model 4, with 16K user RAM; and Model 5, with 32K user RAM.

Each model has 16K bytes of internal ROM, which includes a high level Disk BASIC, a file control system, and terminal software. Operating the screen uses 4K bytes of RAM, so that with the standard model, you have 8K bytes of user RAM.

SYSTEM PERIPHERALS

Although Compucolor provides many I/O ports, its only option to date has been a second micro-floppy disk drive. But, using its standard RS-232 interface, a user can add compatible peripherals of his or her choice.

One of the newest peripherals that has been announced is a remote control device that allows the machine to control thermostats, lights, and appliances on a preprogrammed schedule. The CX10's unique feature is a wireless remote data entry keyboard, so that a person can lie in bed or stand up to 30 feet away and still operate and program the device. The controller is made by Omni Controls in Atlanta, Georgia.

Opposite Page: The diagrams illustrate Compucolor's three types of keyboard, all of which have advanced color graphics capabilities. (Courtesy of Compucolor Corporation)

SYSTEM SOFTWARE

Compucolor has provided a wide range of useful and interesting software systems and programs. It uses an Extended BASIC language in a Disk BASIC interpreter in ROM, which includes 29 statements, 19 math functions, 12 disk file commands, and 9 string functions. It also has 30 different error codes, which instantly signal a mistake, and 36 other error codes work through the file control when users load or read programs onto or from floppy disks.

The machine's disk operating system (DOS) is contained inside the ROM file control system, saving thousands of bytes of RAM, and only two keys are pressed to use it. The DOS and the file control have many other versatile uses as well.

Compucolor's main software strength is in its graphics "plot codes," which provide numerous programming shortcuts for graphics "artists" or designers. For example, different plot codes allow a user to tell—in one or two keypunches—what background colors and images he or she wants on a graph, from a horizontal bar graph to a point-lot curve. A horizontal bar graph takes just six steps. Of course, the graphics software also allows a user to make constantly changing artistic shapes easily, as well.

Compucolor backs up its machine and system software with many well-written and accurate documentation manuals. The company provides a wide variety of disk-based programs, ranging from games to education to engineering. It also provides disk-based system software including assembler, text editor, BASIC editing, debugger, formatter, and screen editor programs.

SYSTEM PRICES

Model 3 costs $1,895; Model 4, $2,195; and Model 5, $2,495. The standard keyboard is in-

cluded with the unit, but the 101-key unit costs an additional $135, and the deluxe keyboard costs $200 more. A Model 9 with a 25-inch color monitor and a 117-key keyboard costs $3,380.

The second Micro-Floppy Disk costs $495; additional 16K RAM board, $375; and keyboard upgrade kits range from $100 to $215.

Although one of the higher priced home computers, the Renaissance Machine is the lowest priced disk-based home computer with extensive color graphics.

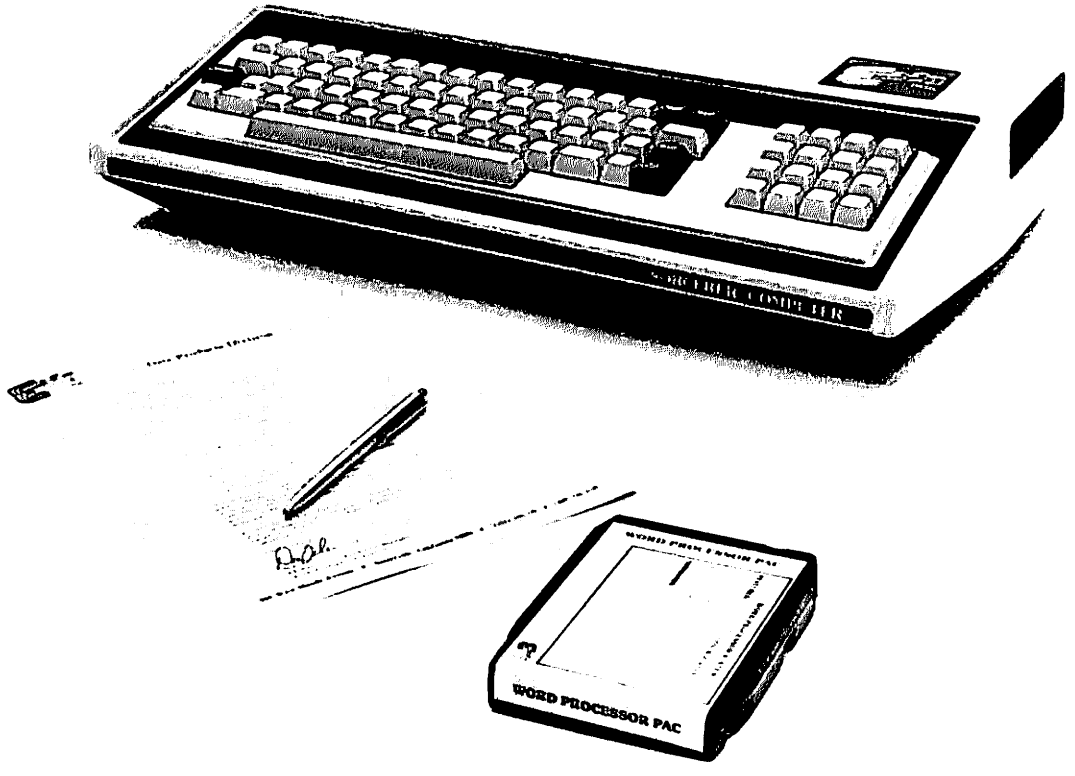
Exidy Sorcerer

Exidy Data Products Division, 390 Java Drive, Sunnyvale, CA 94086, or any of hundreds of dealers and retail stores.

Exidy, Inc., a large video game manufacturer, introduced the Sorcerer in mid-1978 with a particularly unique feature, its ROM-PAC® cartridges, which allowed a user to plug in different computer languages and specific, difficult-to-program applications such as word processing.

Although with the Sorcerer Exidy had early marketing and production problems, along with many other new companies, it gained a significant share of the market. Since then, it has introduced several new peripherals that make its unique features more versatile.

The Exidy Sorcerer is shown with its unique ROM Pac cartridge for a word processing system. (Courtesy of Exidy, Inc.)



The new Sorcerer Video Display Monitor with a 12-inch screen and dual mini-floppy disk drives. (Courtesy of Exidy, Inc.)

SYSTEM DESCRIPTION

Based on the Z-80 microprocessor, the Sorcerer has a large, versatile 79-key typewriterlike keyboard with the number keys on the right side, along with control and command keys. It also has communications, printer, and tape storage interfaces built in, but a user must attach an audio cassette recorder and a video monitor for the machine to operate.

With a standard black-and-white video monitor, the Sorcerer displays high-resolution graphics and a large character format. The 512-point by 240-point format is the largest available in black and white. It displays 1,920 characters in a 30-line by 64-column format, more than equal to a double-spaced typed page.

The user has a choice of up to 128 graphics characters that he or she may define for graphics designs or foreign language symbols. The graphics characters can also be linked together to form block diagrams or line drawings.

In its latest development, Exidy has introduced a black-and-white Video/Disk System, which combines a 12-inch video monitor and two (or dual) mini-floppy disk drives with a 630K byte storage capacity. The video display monitor provides a green-on-black background and clear, high-resolution pictures.

Exidy has made the basic system modular so that users can add expansion boards, additional memory, and dual audio cassettes for application and program input/output with a six-slot S-100 bus expansion unit.

SYSTEM MEMORY

The Sorcerer's unique ROM-PACs® look and work like eight-track tape cartridges, but contain ROM memory, which holds different programming or operating system languages. The Sorcerer itself has 12K ROM, which runs a system monitor and Standard BASIC language. It has 8K or user RAM, which can be expanded to 32K. To add memory, a user must obtain a 16K Memory Expansion Kit.

The ROM-PACs®, introduced two years before Texas Instruments' command modules, contain more Standard BASIC, an assembler, and an editor language in a Development Pac, a DOS operating system, and applications packages such as word processing. A fifth ROM-PAC® allows a user to create his own permanent software through *erasable programmable read only memory* (EPROM), a technical term that means a user can instruct a blank ROM-Pac® with his own programs and make a permanent program.

SYSTEM PERIPHERALS

For almost two years, Exidy relied on Sorcerer users to add most of their own peripherals to the basic unit. That situation is changing as the introduction of the video display/dual disk outfit shows. Further peripherals should be expected during the next few years.

To date, Exidy's peripherals include a S-100 Expansion Kit, an I/O Expansion Kit, two cables for serial or parallel input and/or output, and a 16K Memory Expansion Kit. All of these allow Sorcerer owners to plug in S-100 compatible devices, such as music and speech synthesizers, disk interfaces, more RAM memory, and so forth, but Exidy does not make these itself.

SYSTEM SOFTWARE

Besides its ROM-PACs®, the Sorcerer relies on cassette-based programs for most applications. It also provides standard package, which contains Extended Disk BASIC, an assembly text editor, and a common operating system in a ROM-PAC® in addition to the Development Pac and Word Processing Pac Software systems. It also has a video screen editor system.

Programming languages include an Extended Cassette BASIC, an Extended Disk BASIC, FORTRAN, and COBOL.

SYSTEM PRICES

The basic Sorcerer costs only $995, while the 16K RAM version costs $1,145, the 32K version, $1,295, and the 48K version, $1,445. The Video/Disk Unit, which includes the dual floppy disks, a 12-inch CRT, and all the necessary system software, costs an additional $2,995.

The 16K Memory Expansion Kit costs $160, the S-100 Expansion Unit, $349, and the S-100 interface card, $199, while the three standard ROM Pacs® cost $99 each.

The Sorcerer has many unique and powerful capabilities and continues to have a lot of potential for home and small business applications. But to date, independent hardware manufacturers and software houses have not responded enthusiastically and have not provided as much support for the Sorcerer as they have for more popular home computers.

Atari 400 and 800 Personal Computer Systems

Atari, Inc., 1265 Borregas Avenue, Sunnyvale, CA 94086, or any of hundreds of dealers, department stores, and retail computer stores.

In 1979, Atari, Inc., the company that launched the revolution in video games with its famous Pong game, surprised the personal computing world when it introduced its 400 and 800 model personal computers. Many had expected the

The Atari Personal Computer System includes the small Atari 400 and the more powerful Atari 800 and their peripherals, including two printers, a mini-floppy disk drive or an audio cassette interface, a telephone modem, and software on cassettes, ROM cartridges, or floppy disks. (Courtesy of Atari, Inc.)

creator of Pong and the most popular programmable Video Game System to emphasize games and home entertainment. Instead, Atari attacked the heart of the home computer market and directly challenged Radio Shack, PET, Apple, and Texas Instruments with two systems that contained most of the same features that the four best-selling home computers had, and many new features they didn't have. In 1980, Atari introduced a complete line of peripherals—from printers to disk drives—that staked out a firm place for Atari in the future of home computing.

SYSTEM DESCRIPTION

Both the 400 and the 800 models share many of the same features. (We'll indicate those features that apply only to the 800.) Basically, both models operate from a MOS Technology 6502 microprocessor that generates 16 colors, each with eight different intensities, four independent sound synthesizers for music, and game sounds in four octaves through an internal speaker.

Each model has a 57-letter-and-number keyboard with four function keys. They work both in upper and lower cases and allow full screen editing, four-way cursor control, and 29 keystroke graphics. But the Atari 400 model has a keypadlike keyboard that is touch-sensitive (and inexpensive), while the 800 model has a full typewriter, full-stroke keyboard.

Both have four controller jacks for joysticks and paddle controllers, a concept borrowed from the company's Video Game System and a clear acknowledgement that the company expects most people to play games. Both also have one serial I/O port for hooking up one peripheral.

Although a buyer must use his or her home television or add a color video monitor, both models will generate a 24-line by 40-character display with a high resolution of 320 by 192 points for clear, sharp color.

For mass memory storage, a cassette recorder is an option for the 400 model, but is included with the 800 model.

SYSTEM MEMORY

Both models start off with 8K RAM memory and a 10K ROM internal operating system. The ROM can be expanded to 16K with solid-state cartridge programs that a user plugs into the side of the unit.

The plug-in cartridges also allow the 800 model to expand to 48K RAM, but an Atari service center must install a new board to expand the 400 model to 16K.

The standard memory and programs for both models are contained in the plug-in cartridges. Users can load compatible programs or store their own programs and information on cassette tapes through the Atari 410 Program Recorder, a simple audio cassette recorder.

SYSTEMS PERIPHERALS

Atari has made great strides in peripherals during 1980, introducing at least ten new devices. Company officials promise that new peripherals—some unusual ones—will be added to the system as time and market conditions permit.

At the 1980 Consumer Electronics Show, and in the trade press, Atari's peripherals received widespread applause.

ATARI 850 INTERFACE MODULE — It has four RS-232 I/O ports and directly supports the Atari 830 telephone modem and the Atari 825 80-column printer.

ATARI 810 DISK DRIVE — This mini-floppy disk drive stores more than 92K bytes of data on each diskette. Its internal control system can operate a total of four disk drive units through any 16K RAM model, including an expanded 400 model.

ATARI 820 AND 825 PRINTERS — Atari offers two different printers. The 820 model is an ad-

vanced, "intelligent" printer with its own 6507 microprocessor, a RAM I/O chip, and 2K internal ROM. The 820 is a dot-matrix impact printer that prints 40 characters per line in upper and lower case and uses 4-inch-by-3-inch paper tapes found at any regular office supply or stationery store.

The 825 model printer is a lightweight device (less than ten pounds) that prints 80 characters per line at 100 characters per second. It can accept either roll paper or fan-fold paper and adjusts to different paper thicknesses, but does not require any special paper. It, too, is a dot-matrix impact printer and can be used in practically any small business application.

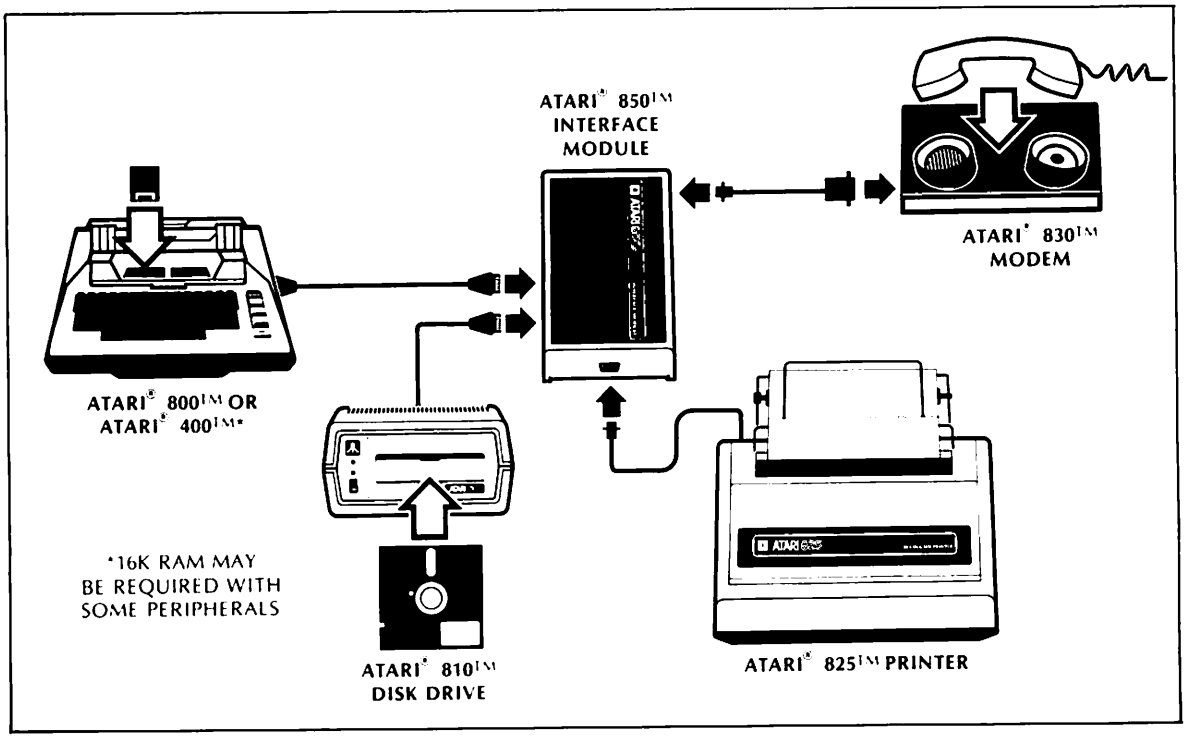
ATARI 830 MODEM — This modem is a standard acoustic coupler and is compatible with almost all regular RS-232 interfaces; it operates through almost all regular telephone lines. It can send information at 30 characters per second and can operate in either "originate" (send) or "answer" mode, so that it operates with modems that can only send or receive digital information.

SYSTEM SOFTWARE

Both the 400 and 800 models come with 8K BASIC language ROM cartridges, an important advantage, because having all the high-level language on cartridge frees most of the RAM for a person to use for programs.

The 800 model also comes with a Talk & Teach® Educational System Master Cartridge. Atari plans to produce additional cartridges

The block diagram illustrates how the Atari Personal Computer System links its home computer with compatible peripherals through an interface module. (Drawing copyright ©1980 by Atari, Inc.) (Courtesy of Atari, Inc.)



with more advanced software and higher level assembly and machine languages.

Atari also has made available dozens of cartridge programs for home entertainment, education, home and financial management, and business management. See the Appendix for a list.

SYSTEM PRICES

The Atari 400 model lists at $540 and the 800 lists at $1,080. The peripherals are competitively priced, with the 820 printer at about $585, the 825 printer about $1,750, the 830 modem at about $200, the disk drive about $500, and the interface module about $400.

Atari continued to expand its line of peripherals in late 1980. It now offers a light pen with software support ($70), a 40-column thermal printer ($450), and an impressive dual-density, dual-disk drive with a capacity of 400,000 bytes (for $4,400).

Prices for its other peripherals include: 80-column dot matrix impact printer, $1,000; and 40-column dot matrix impact printer, part of the Atari 800 package, $600.

In less than a year, Atari has created one of the most complete packages of home computing hardware available, and the company promises to increase its available programs rapidly.

CUSTOMER SERVICES

Atari has moved rapidly to provide the kind of customer service required to service a mass market audience. It has enlisted computer giant Control Data Corporation to operate dozens of regional service centers for warranty repair, safety and engineering changes, equipment upgrades, and service contract repairs. At least 25 centers were operating in 1980.

This service agreement will enable buyers to get relatively fast and professional service through a nationwide network. Most consumers want this kind of service; they do not want to wait weeks to get their expensive computers back from a factory repair shop more than 3,000 miles away. This degree of service brings to home computing an important step toward making the machines home appliances.

These seven home computers make up more than 90 percent of all home computer markets. Although many other microcomputers are for sale, only these seven fulfill our definition of a home computer.

All seven can easily be hooked up to the huge information networks or information exchanges that make up, by far, the potentially most significant use for home computers now and in the future. Consider this: If home computers were not being used for information exchange, why would all these companies introduce their own telephone modems and communications interfaces? If they didn't expect anyone to use them, they wouldn't make them.

Following these companies' leads, let's find out how anyone can turn his home computer into a huge information utility without knowing programming, without spending a million dollars, but with remarkable comfort and ease.

7. Putting the World at Your Fingertips—Easily

TWENTY-EIGHT OF THE MOST IMPORTANT librarians in the United States get together to plan a White House conference on the future of American libraries. They see each other only once during the six months before the conference, yet they hold committee meetings, exchange ideas, plan agendas, and keep in close contact, as often as every day.

An independent investor analyzes her portfolio of 25 stocks, bonds, and options every day and instantly compares a stock's current status to six years of price, earnings, and dividend performance, without poring over thick volumes of reports or doing complex research in a faraway library. All the facts she needs to make swift investment decisions flash onto her television screen.

A business executive remembers at midnight that he forgot to book theatre tickets for an important client in a city 1,000 miles away. He gets out of bed, and within three minutes the reservations are made, the tickets are paid for, and the executive is asleep.

A seven-year-old girl corresponds with a pen pal without ever using a pencil and plays spirited video games with another seven year old although the other child lives 3,000 miles away.

Children in a cerebral palsy school and senior citizens in a home for the aged talk to each other and with hundreds of other people without ever dialing a phone.

These few examples demonstrate the limitless uses that any person—without knowing anything about computer operations or computer programming—can find for home computers through existing information utilities. In fact, the creators of the first information utilities want to make them as essential to the home as water and electricity and more useful than television and all other home appliances. Although these information utilities have not had that kind of impact yet, they probably will change the way all of us communicate with each other within ten years.

Anyone with an inexpensive terminal or a home computer and a telephone modem can join tens of thousands of people who already use these networks every day. When someone joins the SOURCE, MicroNET, or a network like EIES (Electronic Information Exchange System), he or she links into a time-sharing network in much the same way that a small business may use a time-sharing computer to do its payroll, inventory control, or billing. They differ in the amount of information to which they have access. An individual using either the SOURCE or MicroNET can tap huge banks of information, while a time-sharing businessman simply borrows a time-sharing service's programs and memory storage.

The information the networks provide consists of new information to which a user did not have access previously. For example, a new home computer owner who has just bought a TRS-80 may be able to buy 500 different programs and games—if he can find them at a local computer store or order them through the mails—each one costing $8.95 and more. But by hooking up to a time-sharing information utility, he can use any of more than 3,000 pro-

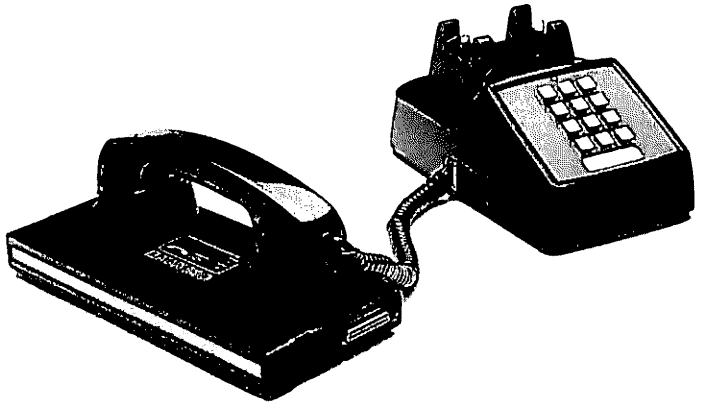
grams. Or, through his computer and a telephone modem, he may "converse" with another computer that is compatible with his, and he can leave messages for and receive them from anyone in that network regardless of the kind of computer he has or where he is located. And he can do it more cheaply than he could make a long distance phone call.

Opening up the Information Window

As we've indicated, becoming part of these growing networks requires only a little money and a simple, working knowledge of terminals and computers. You don't even have to own a home computer; the SOURCE will rent you a terminal and a modem. But what do you need to know to hook up to these fantastic networks?

By now, you know what a modem does—it links a computer or a terminal to the telephone lines. A standard acoustic coupled modem looks like a thin rectangular box with a telephone receiver buried in it up to its neck. Actually, the modem serves a slightly different purpose: the term *modem* stands for "modulator-demodulator" and reflects what the electronics inside the modem actually do. Through the modulator, the modem takes bit streams, or flows of digital information, from a home computer and converts them into low-frequency sound waves that a telephone can "understand." A modulator could be considered to "speak" through the telephone lines to a demodulator at the receiving end. A demodulator, on the other hand, "hears," or receives low-frequency waves, and converts them back into bit streams that a receiving home computer can understand. Most "originate" modems transmit at frequencies between 1270 Hz (Hertz) and 1070 Hz and receive at high frequencies between 2225 Hz and 2020 Hz. An "answer" modem transmits on the high-frequency channel and receives on the lower frequency channel.

An "originate" modem means a modem or terminal that begins a message, and an "answer" modem means the modem or terminal that receives and responds. All standard modems use an RS-232 data communications interface so that they will be perfectly compatible. In addition, many kinds of modems exist: Answer/Originate, Answer Only, Originate



The Atari 830 Acoustic Modem, hooked up to a touch-tone or rotary dial phone, will give you instant access to any home information utility or network. (Courtesy of Atari, Inc.)

Only, and others. For hooking up to networks, a user must have an answer/originate modem, or his computer will be able only to receive or to send information, but not both.

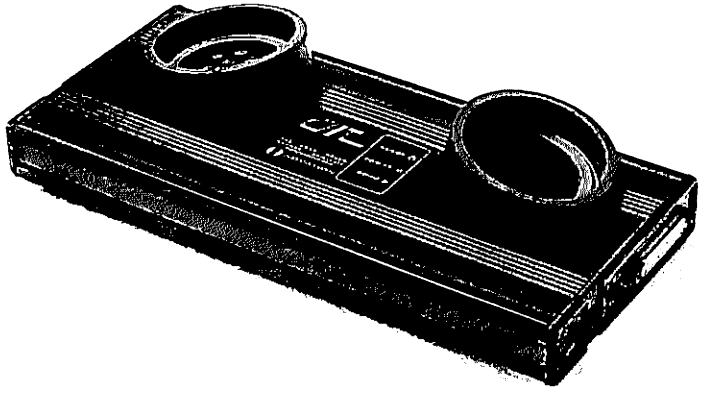
To hook up a home computer to a modem, you attach a communications interface cable to the RS-232 interface port in the back of the modem. (See Fig. 59 for the interface port on the Atari 830 acoustic modem.) Then you attach the other end of the communications interface cable to the same RS-232 interface port, or a special modem port, in the back of the home computer. Although each home computer may have slightly different requirements, those simple steps make up the basic procedure for all.

Modems are almost always considered peripherals on home computers, so that a buyer must pay extra for them. They range in price from a discounted $99 to $395, depending on the features they have. Some have more than one mode of operation, some have LED display panels, some have different communications modes, some are better made than others, some plug directly into a telephone line without requiring a handset, and more. Novation, Inc., of Tarzana, California, produces a full line of modems, including the CAT, which has become very popular among home computer companies, who repackage CATs for their own systems.

But all modems have the two necessary features in common—at least as long as one must use telephone lines to hook up to information utilities: 1) they send and receive information at 110 or 300 baud (bits per second, or about 30 characters a second at the higher rate); and 2) they have the standard interface. The 110- or 300-baud rates make up the maximum rates at which telephone lines can carry computerized information.

To get a home computer working with a network utility after attaching a telephone modem requires making your home computer into a terminal. Some home computers have this *terminal emulator* built in, while others require a short terminal emulator program. Terminal emulator programs for most home computers are already for sale, and some software houses and home computer manufacturers provide terminal emulators on disks, too.

After a terminal emulator program has been entered (if necessary), a user follows simple in-



The NOVATION CAT telephone modem, one of the most popular modems on the market, comes in several models, which can send and receive digital information from a computer or over the telephone lines. (Courtesy of NOVATION, Inc.)

structions to open the window to the network. Connecting to the MicroNET System is described below:

CONNECTING TO THE MICRONET SYSTEM

1. Set your modem for "originate" mode at either 110 or 300 baud.
2. Dial your MicroNET telephone number. When the system answers, you will hear a continuous high-pitched tone.
3. Properly position the telephone handset in the acoustic coupler.
4. Enter the command "Control-C" by typing the character C while holding down the Control (CTRL) key.
5. The MicroNET system will respond by printing the phrase "USER ID:" on your display unit.
6. Enter your User ID number and press the Carriage Return (CR) key. Note: If you are using a half duplex terminal, type the character H preceding your User ID number.
7. The system will respond with "PASSWORD:"
8. Enter your MicroNET password followed by a carriage return. For security purposes, this is a nonprinting entry.
9. The system will respond with your job number and the time, date, and port. This will be followed by a brief message announcing new MicroNET features.
10. When the word "OK" appears on your display, the MicroNET system is ready to receive commands.

    At this point you may wish to type the word "NEWS" to receive more detailed information on the latest additions and enhancements to the MicroNET service.
11. To disconnect from the system, simply type the word "BYE" followed by a carriage return and hang up the telephone.

Don't be afraid of making mistakes. If you make an error in typing your User ID number or Password, the MicroNET system will give you a chance to try again.

That's all there is to it. Tying into the SOURCE requires similar steps. Before an interested person can use either system, of course, he must join the network.

Joining the SOURCE

The SOURCE information utility, the creation of Telecomputing Corporation of America in McLean, Virigina, is an independent, 24-hour-a-day time-sharing network. In mid-1980, a new user had to pay a $100 one-time connection fee and charges for the time—in one-minute increments—he or she spent linked to the system. Those charges were $15 an hour or 25 cents a minute during the busy daytime hours from 7:00 A.M. to 6:00 P.M., but only $2.75 an hour for nights, weekends, and holidays. An additional charge of 3.3 cents per day is charged to users who store blocks of 2,048 characters within the SOURCE computer's memory. The network waives the hook-up fee when someone buys or leases its own terminals.

The SOURCE is available to anyone in more than 250 U.S. cities with a local telephone call. When someone wants to join the network, he fills out an application and sends in his one-time fee, by either check or credit card. The SOURCE then sends him operating booklets, instruction manuals, and an identification number through which he can access the network and be billed for the services he uses. The new client can review the manual and start using the network within about 15 to 30 minutes. The SOURCE sends a monthly bill or charges the user's credit card.

The SOURCE offers two terminal models, a Source I, for $595, and a Source II, for $995; both include a video screen, a keyboard terminal, and a telephone modem. It offers a printer for another $495. The terminals are for sale at the SOURCE's hardware franchises, the first three of which are located in Atlanta, Georgia, Colorado Springs, Colorado, and Washington, D.C. The SOURCE also has a retail showroom in its McLean headquarters. The company has

an ambitious franchise marketing program and sells its service through many computer stores.

Using the SOURCE

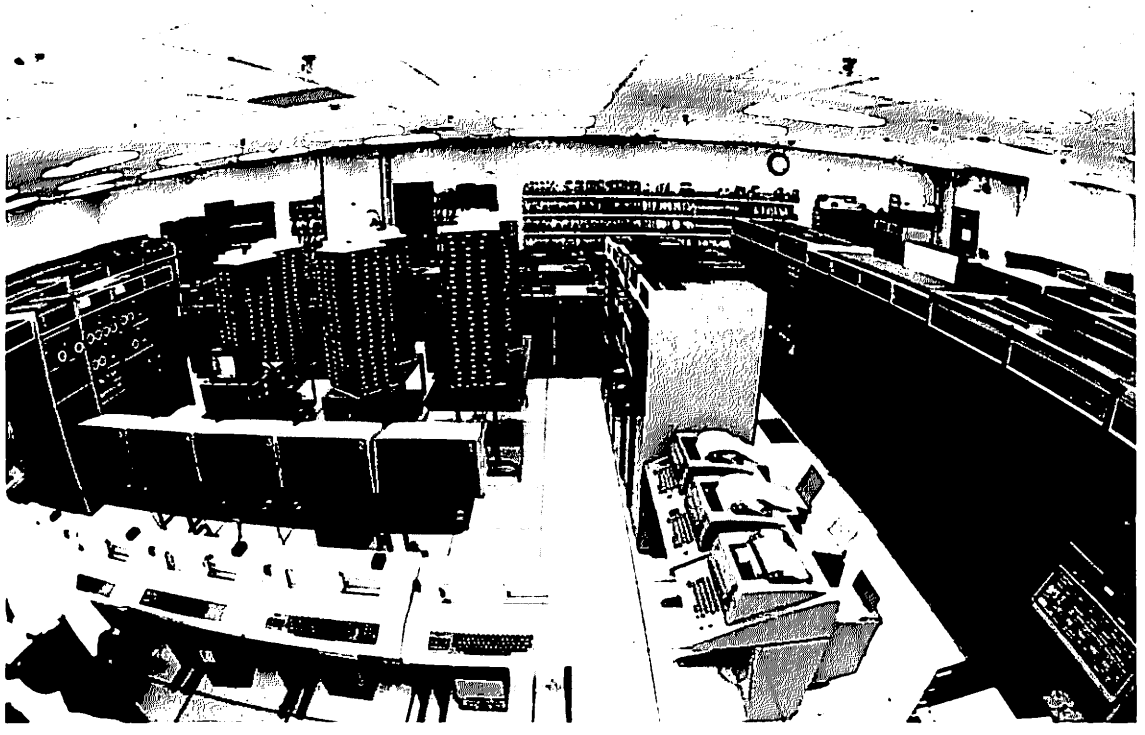
As we've indicated, the SOURCE provides an incredible array of information services. Although many of the utility's programs appeal to small business people, others who just want to use the SOURCE at home may not find these services useful. For example, early experiences with the SOURCE show that, at this time, it is still 25 to 50 times cheaper to buy a daily newspaper than to call up the United Press International news wire and read the news stories as they appear on a video screen.

But many people would, instead, send letters across the country for less than a nickel if they could get the letters there within minutes or hours. The SOURCE can relay electronic mail anywhere in the United States from one terminal to another at any time. A two-paragraph letter can be sent for 4.5 cents, at a time when postage stamps cost 15 cents each.

Many people, using the SOURCE's so-called "chat" program, prefer to send messages to each other for the regular charge of $2.75 an hour, instead of talking on the phone. At 4.5 cents a minute, that's cheaper than calling from Manhattan to the Bronx in New York City, although, of course, you do have to own a home computer. But the telephone company leases a telephone to you comparatively cheaply.

These two features promise to be the most

The MicroNET computer center, located in two places in central Ohio, uses Digital Equipment Corporation's KI-10 and KL-20 mainframe computers to control the time-sharing network and information utility. (Courtesy of Compuserve Corporation)



popular ones for any information utility. People will also hook up to a system to get information they need right then—travelers will want long-range weather forecasts (so will a commodities dealer or investor), or entertainment guides and ticket reservations; children will want to play games that are not available anywhere else; shoppers will want product safety reports on appliances; and so forth.

Joining MicroNET

MicroNET is a division of Compuserve, Inc., which is already one of the country's largest time-sharing computer service companies. Compuserve began MicroNET in 1979 because it realized that its huge bank of 15 mainframe computers was practically idle during evenings, weekends, and holidays. MicroNET is offered from 6:00 P.M. to 5:00 A.M. and has more limitations than the SOURCE, but it, too, has many interesting features and advantages.

As we've seen, joining MicroNET is simple. MicroNET has an inexpensive one-time hookup fee of $9, which the company refunds to you with one free hour of connection time, and it costs $5 per hour. It charges more to buy programs through its unique Software Exchange. But it provides free use of its computers' central processing units for running or writing programs and their memories for file storage of programs or information. It also does not have a minimum monthly billing charge.

Because MicroNET uses a different packet-switching network from the SOURCE, it can only provide access with a local telephone call from 175 cities (in late 1980), but access from an additional 153 cities is provided for an extra charge of $4 an hour.

If someone wants to join MicroNET, he or she need only send in an application. MicroNET will return a user's kit with the new user's private identification number and good documentation of the network. The documentation includes MicroNET Communications Standards for people using home computers; a File Generator and Editor (FILGE) reference cards with commands; a BASIC language reference book for comparing MicroNET BASIC with a user's home computer's BASIC and writing programs to sell through the MicroNET Software Exchange; and a primer and reference book on the MicroNET Integrated Command System. The kit also provides a private password and an appropriate telephone access number.

MicroNET's Services

MicroNET has limited its computing services to practical personal programs, educational aids, business applications, games and simulations, and beginning and advanced programming languages. But it has concentrated on its Community Bulletin Board, Software Exchange, and Micro-Quote, a stock, bond, and option library. Another interesting service is its News feature, which works as MicroNET's own computerized newsletter or electronic newspaper. The feature describes new programs, lists notices for computer club members, discusses tips on how to improve use of the network, and provides other helpful information about MicroNET's operation and services.

The Software Exchange gives users the chance to buy programs and have them transmitted directly from MicroNET's electronic catalog. A user can request to buy a program with a simple command. Instantly, the network will "down-line" or send the purchased program to a user's computer system for permanent storage on cassette tapes or floppy disks. When the program transmission ends, the network automatically charges a user's account. MicroNET has encouraged hundreds of software authors and distributors to sell their products through the exchange.

The sample shown here describes the exchange and how a MicroNET customer can get the listings in the current catalog.

After a user connects his computer to the network, he types in "r softex" and the network

```
r softex
Welcome to the MicroNET Software Exchange (TM)

Library last updated on 25-JAN-80

Do you need instructions? yes

The MicroNET Software Exchange (TM) is an on-line
software distribution system.  You can examine
the current catalog of available software by
choosing an appropriate category and hardware.
If you are running a MicroNET Executive program,
you may also elect to have certain programs
sent to you over the telephone line directly
into your computer.  Billing is done via your
charge card.  You will not be charged for the
connect time during the transfer process,
except for public-domain offerings.

Please report difficulties or any other comments
via the MicroNET FEEDBK program.


Are you running a MicroNET Executive? no

The following categories of software are available:
*  1  EDUCATION
*  2  BUSINESS
*  3  GAMES
*  4  PROGRAMMING TOOLS
*  5  ENERGY MANAGEMENT
*  6  COMMODITIES

Enter the number of your choice: 1

The following sub-categories are available:
   1  MATH DRILLS
   2  PRESCHOOL SKILLS
   3  GRAPHING SKILLS
   4  VOCABULARY AND SPELLING
   5  MATH TOOLS
   6  APTITUDE TESTS

Enter the number of your choice: 4


  Number  Name              Size Cost

000020 WORDSMITH              11K $9.95
        for APPLE II INTEGER
000005 MINICROSSWORD          21K $14.95
        for TRS-80 TRSDOS

Do you wish to view the descriptions of
these programs? yes

000020 WORDSMITH              11K $9.95
        for APPLE II INTEGER
    -- View (Y or N)? y


Program name: WORDSMITH

Program owner: CLIFFORD T. SCHAFER

!THIS PROGRAM IS WRITTEN IN INTEGER!
THE WORDSMITH PROGRAM IS A ONE OR TWO
PERSON GAME WHERE THE OBJECT IS TO
GUESS THE WORD SELECTED BY THE OTHER
PLAYER OR THE COMPUTER. THE SCORING
MAKES EXCITING, COME-FROM-BEHIND VIC-
TORIES POSSIBLE.
FIVE WORDS MUST BE ENTERED, IN SECRET,
FOR EACH PLAYER. IF YOU ARE PLAYING
THE SOLITAIRE GAME, YOU CAN PRESS
"RETURN" AND GET ONE OF THE 475 WORDS
STORED IN THE PROGRAM TO BEGIN PLAY.
AFTER EACH SIDE HAS ENTERED 5 WORDS,
THE GAME WILL BEGIN. THE COMPUTER WILL
DISPLAY EACH SIDE OF THE GAME AND 10
DOTS TO REPRESENT THE WORD TO BE
GUESSED. THE GAME IS PLAYED BY GUESSING
A LETTER OR LETTERS THAT MIGHT BE IN
THE WORD. EACH TURN COSTS 10 POINTS.
DOCUMENTATION WILL BE MAILED TO YOU
UPON VERIFICATION OF YOUR ORDER.


Cost:       $9.95
000005 MINICROSSWORD          21K $14.95
        for TRS-80 TRSDOS
    -- View (Y or N)? n


Do you wish to choose another category? n

Thank you for using the MicroNET
Software Exchange (TM).

OK
```

Reproduction of a printout that a user obtained from the MicroNET Software Exchange. During the entire run, the user typed in the following words representing his entire knowledge of computer programming: yes, no, 1, 4, yes, Y, n, n. The utility did the rest. (Courtesy of Compuserve Corporation)

displays a welcome message and asks if the user needs instructions. If someone answers yes, it displays a short description of the exchange and ends with another prompting question. Then it displays six numbered categories of available software and asks a user to enter one number. It then lists subcategories and again asks for a numbered choice. It describes all the programs within that subcategory, including each program number, name, and cost. After a subcategory listing, it asks for a simple yes or no answer about complete program descriptions. If the answer is yes, it then lists each program and asks the user to signify with a Y or N (for yes or no) whether she wants a description of that program. If a user keys in "Y," it gives a descrip-

```
User ID: 70000,1@chb
Password:

Job 17 on MicroQuote at 15:05 14-Feb-80 on
T03CLJ

MQUOTE  V 1(1),204   14-Feb-80   15:06

For information and price list
   enter INFO


****NEWS****

  QPORT, a portfolio processor is now
  available.

  Type QPORT at the PROGRAM: prompt and
  ask for instructions.  There are no
  special fees for instructions.

  You now will be notified at the end of
  a MicroQuote session of how much you
  have incurred in MicroQuote fees.  You
  can also get this information during a
  session by typing CHARGES at the
  PROGRAM: prompt.

  Two other commands have been added:

       CATALOG  prints a list of QPORT
                portfolio files

        NEWS     Types out NEWS (if any)
                i.e. this message


PROGRAM: EXAMINE


EXAMIN   V 11(1),1   14-Feb-80    15:06


ISSUE:  IBM
CUSIP NUMBER = 45920010
SECURITY CLASS = EQUITY ISSUE
EXCHANGE CODE = N (NEW YORK)
TICKER SYMBOL = IBM
ISSUER = INTERNATIONAL BUSINESS MACHS
ISSUE =
ISSUE TYPE CODE = 0 (COMMON)
SIC CODE = 3573
TRADING STATUS = 0 (ACTIVE)
MARGINABLE
S&P RATING = A+
PRICING HISTORY BEGINS 12/31/73
LATEST PRICING DATE = 2/13/80
LATEST CLOSE = $  69 3/8
LAST RECORD UPDATE = 2/13/80
SHARES OUTSTANDING = 583,374,000
LATEST 12-MONTHS EARNINGS DATE = 12/31/79
12-MO. EPS = $5.160
EPS: PRIMARY EPS (COMPANY REPORTED)
INDICATED ANNUAL DIVIDEND = $3.440
IAD: REGULAR RATE
BETA FACTOR = .813
BETA CENTILE = 59
DIVIDENDS HISTORY BEGINS 2/5/68 AND ENDS 2/6/80



ISSUE:

PROGRAM: PRICE


PRICE   V 10(1),531   14-Feb-80   15:07

(P)rices or (D)ividends?  :p

Issue  ?  :IBM

(D)aily, (W)eekly, (M)onthly? :M

Starting date :   JUNE 1, 1979
Ending date   :   DECEMBER 1, 1979

45920010   N  IBM
        INTERNATIONAL BUSINESS MACHS


PRICING HISTORY: 12/31/73 TO  2/13/80

MTH-END    MONTHS    MONTHS MONTHS MTH-END
  DATE     VOLUME    HI/ASK LO/BID CLS-BID
-----------------------------------------
 6/29/79    79090    78.50  72.13  73.38


 7/31/79    87888    76.75  68.00  69.75
 8/31/79    92145    72.50  68.25  70.00
 9/28/79    88737    71.38  65.75  67.75


10/31/79   114818    69.50  61.13  62.38
11/30/79    84723    67.00  61.13  65.25
```

An example of the information available through MicroNET's new MicroQUOTE stocks and bonds listing service. The figure analyzes the Price and Examine functions of the system for one stock for a six-month period. The user entered only the following words into the computer while the computer did the rest: EXAMINE, IBM, PRICE, p, IBM, M (for monthly), CHARGES. (Courtesy of Compuserve Corporation)

tion of that program, including its author, cost, fundamental operation, and required computer configuration.

From this example—which closely resembles the way most home computer programs operate, with detailed prompting questions, simple answers and short entries—one can understand how simply and quickly one can take advantage of these huge networks.

Like the SOURCE, MicroNET has proved to be most useful to people who want to reach other people quickly, inexpensively, and at a

```
r bullet
6 minutes used

MicroNET Nationwide Bulletin Board
Use the HELP command for further information.


*help

The MicroNET Nationwide Bulletin Board is an information
exchange medium.
The following commands are implemented:
        SCAN     READ      INDEX     VIEW
        COMPOSE  POST      EDIT      ERASE
        CHECK    EXIT      AGE       OFF
Commands may be abbreviated to the first 3 letters.
For additional information about a command, type:
HELP command
For example:    HELP SCAN

*nelp scan

The SCAN command displays a list of waiting message numbers.
It is entered as follows:
       SCAN kind keyword
where kind is USER, SALE, WANTED, or NOTICE.  The keyword is
optional.  SCAN USER will display only those messages which
have been sent to you.  The number which is given by the
SCAN command may be used in the READ command.
For example:
       SCAN NOTICE GAMES
If SCAN is entered without anything else, then a summary
of the length of each queue will be displayed.

*scan sale

   #       From:    Date:     Keyword:

 247    70210,254  12-Feb-80  'TENEMENT'
 159    70240,110  12-Feb-80  APPLE
  80    70160,125  11-Feb-80  ASR33'S
  92    70240,122  10-Feb-80  ASR-33
  41    70300,134  10-Feb-80  CENTRONICS
  11    70160,125  10-Feb-80  HAMGEAR
 222    70160,125  10-Feb-80  PDP8E/11S
 229    70160,125  10-Feb-80  TEK/SCOPES
 183    70160,125  10-Feb-80  TRS80SAND
 210    70320,122  09-Feb-80  FOOTBALL
 125    70040,250  07-Feb-80  PRINTER
   1    70010,241  06-Feb-80  2716PROM
 196    70260,113  06-Feb-80  SPACENEWS
 166    70150,127  03-Feb-80  NORTH*
  78    70240,110  02-Feb-80  APPLE
  63    70340,107  02-Feb-80  HEY.BUZ!
  31    70250,103  02-Feb-80  MONITOR
 131    70110,131  02-Feb-80  PRINTER
  61    70004,144  01-Feb-80  HOUSTON-MI
   4    70160,103  01-Feb-80  POLY8813

*view 247

Incorrect message type.
SALE, WANTED, NOTICE or USER expected.

*sale

I don't understand that command!

*read 247

       NOW AVAILABLE FOR THE TRS-80 MICROCOMPUTER!!!! THE GAME OF
''TENEMENT''. LIVE ALL THE EXCITMENT AS YOU FIGHT YOUR WAY OUT
OF A BURNT OUT BUILDING, AND FIGHT SOME OF THE MOST DANGEROUS
FIENDS IN A SLUM!!!
       IT HAS TO BE PLAYED TO BE BELIEVED!
       ONE OF THE FUNIEST GAMES I'VE RUN ACROSS! AND NOW AVAILABLE
FOR DISK BASIC, FOR ONLY $5.00 OVER THE MICRONET TO YOUR
COMPUTER.
       FOR MORE INFORMATION CONTACT
              SCOTT LIEBERMAN
               70210,254
```

An example of the MicroNET Nationwide Bulletin Board. The user again receives prompting and instructions, which guide him through the system step by step.

time of their own choosing. Its Nationwide Bulletin Board (which a user calls up with "r bullet") serves as an information exchange network. A user can compose, edit, and post or send messages; he can scan a list of waiting message numbers in four categories, including an electronic classified advertisement service called "Sale" and "Wanted" and a display advertisement service called "Notice." The example shown here demonstrates how extensive this bulletin board can be.

Under one subcategory, Scan Notice Games, 20 different computer games are listed for sale. Network users can then type in "*view and a message number" and get a complete rundown of what each program offers. It gives the author's name and MicroNET identification number so that an interested member can send the program author a message that he wants more information about his program. (A program author receives royalties on each one sold.)

A curious subscriber can also use the complete MicroNET Index to locate any other person in the system. The Index serves as an electronic telephone directory, with much more information and many ways to interact. The Index also allows one user to send information in text or programs to other network members; a member selling programs through the bulletin board can send his programs to a buyer this way.

A member can also access the network, send a message or program, and leave it as a piece of mail for someone else. A member can send in one message, type in five numbers, and leave that message for five different members, or five messages for 50 different network members, or any number of combinations as long as the user wants to type in messages and member numbers.

Although both MicroNET and the SOURCE will have a total of 100,000 members by early 1981, the possibilities seem enormous for these two and any new information utilities, especially since both constantly add new sources of information (also called data bases). The SOURCE has added the Official Airline Guide, a complete list of all North American flights by commercial airlines. The biweekly publication costs $92 a year in print, but only 4.6 cents a minute to someone interested in the cheapest flight from Boise to Birmingham. The SOURCE has also added an entire set of encyclopedias and a world almanac, which would be expensive for a family to buy, but cheap for a family to access for a few minutes so that Johnny or Susie can get out a printout about atoms or zebras for a school report. MicroNET also has added encyclopedias, dictionaries, and other reference materials and ticket and shop-at-home services to its network.

Computer Neighbors

Although the two information utilities begin to bring people closer together through home computers, they cannot compare to the new kinds of togetherness and sociability that EIES and similar networks have created. The impact of these conferencing networks should not be underestimated. In addition to the 800-member EIES, more than 75 computer bulletin boards or information exchange networks already exist. They range from simple message boards to sophisticated conferences on home computer applications for handicapped people. One network even carries an electronic newsletter on genealogy.

These applications illustrate what Murray Turoff has predicted for electronic information exchange systems. Home computer owners, with an astounding variety of business and professional interests, hobbies, and just plain curiosity about the world, want to learn more about the world through the fastest, most capable means possible—the home computer.

(Opposite page) List of 58 Community Bulletin Board services. Each of the 58 can be accessed using at least one kind of home computer.

```
INITIAL CHOICE??cbbs

                (Revised 10/02/79)

This is a list of CBBS and similar message exchange systems.
The codes BPM to the right of the page represent various
system features. An X under a heading indicates the presence
of a feature.  Also, a specific code may appear under a
heading.  Here are the meaning of the specific codes:

B - Bulletin Board
  C = CBBS (Community Bulletin Board System - 8080 C)
  M = MINICBBS (must type MINICBBS after system says A>)
  A = ABBS (Apple Bulletin Board System)
  F = Forum/80 (TRS-80 under TRSDOS)
  D = ADGBS (Akron Digital Group Bulletin Board Syst)
      (Similar to CBBS - no CTL-C, CTL-K functions.)

P - Programs also available (code for operating system)
  C = Remote CP/M
  N = Remote Northstar
  A = Remote Apple DOS




M - Machine
  8 = Generic 8080
  6 = Generic 6800
  A = Apple
  T = TRS-80

These systems are all available for public use at no
charge.  Please feel free to try them.  Two or more carriage
returns are usually required on microcomputer systems -
carriage return, line feed on larger systems. Most are 300
baud, but some CBBS's allow 110, 300, 450 and 600.
```

STATE / Name	Location	Number	B	P	M
CALIFORNIA					
Forum/80 Orange	Anaheim	714-991-3640	F		T
Apple Corps ABBS	Canoga Park	213-340-0135	A		A
	Fresno	209-638-6392			
Hawthorne ABBS	Hawthorne	213-675-8803	A		A
Korsmeyer ABBS	Huntington Bch	714-962-7979	A		A
Has 10 M-byte hard disk					
Computer World ABBS	Irvine	714-751-1422	A		A
CCI Southbay ABBS	Lawndale	213-370-3160	A		A
Hours 8PM - 8AM M-S All day Sun					
ABBS/Long Beach	Long Beach	213-428-4718	A		
ABBS/Marina Del Rey	Marina Del Rey	213-821-7369	A		A
CBBS/Pasadena	Pasadena	213-795-3788	C		8
Comp. Merchant ABBS	San Diego	714-582-9557	A		A
ABBS/PCNET	San Francisco	415-948-1474	A		A
Operated by the PCNET committee					
Forum/80 SF	San Francisco	415-348-2139	F		T
ABBS/Computer Store	Santa Monica	213-394-1505	A		A
Hours (PST) 8PM-10AM Tue-Sat All day Sun-Mon					
People's ABBS	Santee	714-449-5689	A	A	A
Almost all national activity - system hacker types					
Peripherals, Unltd.	Signal Hill	213-424-3506	A		
ABBS/CCI	Westminster	714-898-1984	A		
DISTRICT OF COLUMBIA					
AMRAD	Washington	703-281-2125	X		6
Amateur radio operators, with an on-the air link					
GEORGIA					
Computerland ABBS	Atlanta	404-953-0723	A		A
Microstuff, Inc.	Atlanta	404-939-1520		N	
	Atlanta	404-325-0526		C	8
CBBS/Atlanta	Atlanta	404-394-4220	C		8
ILLINOIS					
CBBS/Ward & Randy's	Chicago	312-528-7141	C		8
Forum/80 Chicago	Chicago	312-925-0259	F		T
Sends graphics to TRS-80's!					
KANSAS					
Engineer/80	Olathe	913-764-1520	F		T
Messages concerning engineering applications					
Forum/80 Wichita	Wichita	316-746-2078	F		T
MASSACHUSETTS					
ABBS/Boston	Boston	617-354-4682	A		A
CBBS/Boston	Boston	617-963-8310	C		8
Forum/80 SBSG	Dunstable	617-649-7097	F		T
New England Comp Soc	Maynard	617-897-0346	X		
Running on a machine at DEC					
MICHIGAN					
CBBS/Computer Mart	Detroit	313-288-0335	C		8
SEMCO MISD	Macomb County	313-286-8820	X	X	
Access code: HEL-R901,SEMCO					
SEMCO WISD	Westland	313-326-6050	X	X	
" " mux (300 baud)	Grosse Pointe	313-343-2375			
" " mux (110 baud)	Grosse Pointe	313-343-2370			
Access code: HEL-Z301,SEMCO					
Remote CP/M	Royal Oak	313-588-7054	M	C	8
Ring once, hang up, call again. Second call answered.					
MISSOURI					
EMS	Kansas City	816-737-1031	X		6
Computerized conferencing experiments					
Forum/80	Kansas City	816-861-7040	F		T
8pm to 4pm weekdays - after 8pm weekends					
Forum/80 St. Louis	Saint Louis	314-838-7784	F		T
NEVADA					
Forum/80	Las Vegas	702-873-9112	F		T
Not yet operational, coming soon.					
NEW JERSEY					
SJ Electrnc Mail Ctr	Bound Brook	201-457-0893	X		6
Access code: HEL-I999,MAIL					
Forum/80	Princeton	201-874-6833	F		T
NEW YORK					
??? (Bob Iannucci)	Endicott	607-754-5571	X		8
Interesting CBBS variant with new features					
ABBS/NY	Staten Island	212-448-6576	A		A
OHIO					
Akron Digital Group	Akron	216-745-7855	D		8
OREGON					
CBBS/NW	Beaverton	503-646-5510	C		8
SOUTH CAROLINA					
Compusystems	Columbia	803-771-0922			X
"RSTS-80" - Northstar - programs only					

USER'S GUIDE FOR ELECTRONIC INFORMATION EXCHANGE SYSTEM

START

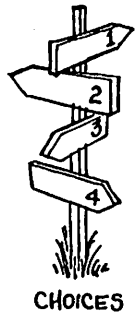
NAME/#? CODE

?

ACCESS TO:
- MESSAGES (1)
- CONFERENCES (2)
- NOTEBOOKS (3)
- BULLETINS (4)
- DIRECTORY (5)
- EXPLANATIONS (6)
- REVIEWS (7)
- COMPOSITION (8)
- MONITORING (9)

INITIAL CHOICE?

? Questions Asked



CHOICES

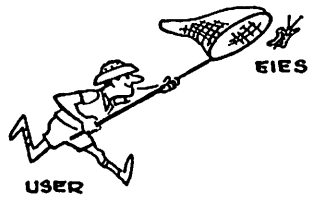
EIES

Computerized Conferencing and Communication Center
New Jersey Institute of Technology
323 High Street
Newark, N.J. 07102
201-645-5503

Designer:
Murray Turoff
Department of Computer and Information Science

Support: NSF
Communications: TELENET
Equipment: INTERDATA

Implementation:
NJIT & LSD



1

GET ITEMS (1)
DISPLAY TITLES (2)
SEARCH/FIND (3)
SEND/COMPOSE/SUBMIT (4)
EDIT/DELETE (5)
ORGANIZE ITEMS (6)
VOTE/FORM (7)
SET OPTIONS (8)
.....CHOICE?
(Message/Conference/ Notebook/Report/ Assessment/News)

2/3 ?

1/2/3

4 ?

ACCESS TO:
- NEWS (1)
- ASSESSMENTS (2)
- ABSTRACTS (3)
- REPORTS (4)
- DESCRIPTION (5)

FUNCTIONS FOR:
- REFEREES (6)
- EDITOR (7)

BULLETIN CHOICE?

5

- GET ITEMS (1)
- DISPLAY TITLES (2)
- SEARCH/FIND by:
  - NAME PARTS (3)
  - FROM-TO-DATES (4)
  - WORD/PHRASE (5)
  - ZIPCODE (6)
- UPDATE ENTRY (7)

DIRECTORY CHOICE?

6

- GET ITEMS (1)
- DISPLAY TITLES (2)
- SEARCH/FIND (3)
- EXPLANATION OF:
  - GENERAL DESIGN (4)
  - SPECIFIC CHOICES (5)
  - CONTROL FEATURES (6)
  - ANSWER AIDS (7)
  - TEXT EDITING (8)
  - DOCUMENT EDITING (9)
  - COMMANDS (10)
  - SPECIAL FEATURES (11)
  - HAL (999) (12)

EXPLANATION CHOICE?

7

- MESSAGES (1)
- CONFERENCES (2)
- NOTEBOOKS (3)
- BULLETINS (4)
- MEMBER/GROUPS (5)
- MEMBER STATUS (6)
- GROUP STATUS (7)
- SYSTEM STATUS (8)

REVIEW CHOICE?

8 *Scratchpad (SP) & Storage Areas (S,A)*

USE TEXT FOR:
- MESSAGE (1)
- CONFERENCE (2)
- NOTEBOOK (3)
- BULLETIN (4)

CONTINUE AND:
- SAVE TEXT (5)
- GET TEXT (6)

RETURN TO SP (7)
COMPOSE CHOICE?

9

- MESSAGES (1)
- CONFERENCES (2)
- NOTEBOOKS (3)
- BULLETINS (4)
- MEMBERS/GROUPS (5)
- EXPLANATIONS (6)
- PROCEDURES (7)
- ACCOUNTS (8)

MONITOR CHOICE?

1/2 ITEM NUMBERS (#, #-#)?

3

SEARCH BY:
- NUMBERS/NAMES (1)
- STATUS/TYPE (2)
- COMBINATIONS (3)
- FROM-TO-DATES (4)
- WORDS/PHRASES (5)
- ASSOCIATIONS (6)
- SEQUENCES (7)

DISPLAY STRUCTURE OF:
- KEYS (8)
- ASSOCIATIONS (9)
- SEQUENCES (10)

SEARCH CHOICE?

4 *Scratchpad (SP) & Storage Areas (S,A)*

5 ITEM NUMBER(#/-#)?
(-# for DELETE)

6

- REVIEW STATUS (1)
- EXCHANGE ITEMS (2)
- COPY/MERGE ITEMS (3)
- TRANSFER/MOVE ITEMS (4)
- MODIFY FOR ITEMS:
  - KEY WORDS (5)
  - ASSOCIATIONS (6)
  - SEQUENCES (7)
- DISPLAY STRUCTURE OF:
  - KEYS (8)
  - ASSOCIATIONS (9)
  - SEQUENCES (10)

ORGANIZE CHOICE?

7

- GET ITEMS (1)
- DISPLAY ITEMS (2)
- FIND/REVIEW (3)
- VOTE/FILL IN (4)

VOTE/FORM CHOICE?

8

OPTIONS FOR:
- MARGIN/LINE CONTROL (1)
- ON/OFF OF:
  - LINE PAUSE (2)
  - MENU LISTS (3)
  - AUTOMATIC DELIVERY (4)
  - RECEIVE ONLY (SLEEP) (5)

ESTABLISH:
- MEMBER LINK (6)
- REMOTE PRINT (7)
- PARAMETER CHANGES (8)
- PROCEDURES (9)

SET CHOICE?

CONTROL FEATURES FOR USE OF MENUS:

- \+ Go back/finished questions/ finished text/when in doubt do it
- ++ Go to INITIAL CHOICE/ request messages
- ++# Go to INITIAL CHOICE: #
- \- Start over/made mistake/ stop and go back/ ignore answers/don't do it/ terminate string variable
- BK Break Key stops printout
- -- sign off

An even more intriguing possibility has been demonstrated through EIES. Any EIES member can send a message to any other EIES member, just as in the two information utilities, but EIES has also created groups of members. Some groups have organized for specific purposes, such as a group of experts who have created data bases on viral hepatitis. But other groups allow anyone to join their groups for discussions about particular topics.

Rather than going to two-day conferences—and spending thousands of dollars to travel across the country—experts who don't know each other, or people from different disciplines, can join the same group and share ideas and determine methods to solve problems. As a high-level example, EIES's Politechs-Legitech group perfectly illustrates this sharing principle: 25 state legislative science advisors frequently exchange ideas and responses about public issues—such as disposing of toxic chemicals and licensing child care centers—singly, in small groups, or in a whole conference. To get the same information under normal conditions, one science advisor would have personally to write or call all 24 others or attend a conference and personally speak to all 24. Under ordinary conditions this would be difficult. But with EIES, any one of the 25 can ask the same question of all the others and receive answers within minutes. They can exchange messages with other members or with all 25 at the same time, and they can suggest specific sources of help and more detailed information that a member may never have heard before.

When one begins to consider how people work together in an office or at home—sharing ideas, swapping tips on where to find help, providing direct aid when possible, complaining, criticizing, praising, encouraging, and so on—one can begin to imagine what easy, inexpensive computer networks could do to bring people closer together.

As I've shown, using EIES is as simple as using a home computer. The EIES User's Guide lists, in a simple block diagram, the simple steps an EIES member takes to gain access to the information categories he wants. After following the same kind of steps to gain access to the EIES network, a member first enters his or her name or code number. Then, if he's interested, he can get a list of those other members using the system at the same time and a list of private messages, group messages, and message confirmations. Then he can type in one of nine numbers to gain access to one of nine types of information ranging from messages to compositions. If the member types in "4," he receives a menu, or list, of the kinds of bulletins within the system's memory. It has five kinds of bulletins and two functions. After he chooses one of the seven, the network gives him an instant display or printout of that category.

If he has chosen initial choice "2," he will have entered the menu for conferences. From the menu, he could choose from eight categories or one individual choice. The conference categories range from a survey or poll option called "vote/form" to a message transmission option called "send/compose/submit." With the latter, he could enter his thoughts or message into the conference of his choice. The combinations of ways to use an EIES network are practically endless. Once a member has reached the choice he wants, which takes just a few seconds, he can then utilize three additional pages of control, text/edit, address, and variables commands.

Beginning to do all of these thousands of things costs very little. Murray Turoff, who founded the system, usually uses a $1,000 Teletypewriter 33 terminal with an 8-inch-by-11-inch printer because he wants hard-copy printouts of everything in the system. But many users simply rely on their home computers' video displays. You can gain access to EIES or any similar network with the same equipment and in the same basic way you gain access to the SOURCE or MicroNET. Each has slightly different commands, but each relies on simple number-and-letter answers to prompting questions. With EIES, you can use any of 104 commercial terminals or any home computer that

has a standard RS-232 interface, a modem, and a simple program.

These first networks shape only the beginning of electronic networks, which could encourage brand-new ways through which thousands of people with similar interests or desires can reduce the many social barriers that tend to separate people from each other.

These systems do have their drawbacks: they still are expensive for an average family to use extensively; they may provide too much information and encourage indecisiveness; they may be offering too much information of a kind that most people don't want; and they may not respond quickly enough to adapt to these needs because profits may decrease. But one conclusion is appropriate—the networks of 1982 will not resemble those of today. Electronic networks will soon have a huge impact on education, libraries, and information industries such as the stock market, credit, advertising, and insurance—in fact, on every walk of life. That impact will accelerate and may transform our society in the late 1980s and 1990s, as much as television did in the 1950s and 1960s. The change will probably take giant steps away from television's passivity to the activity of sharing networks, which can open ever wider windows to a smaller and smaller world.

8. The Mind Appliance: The Once and Future Computer

A FEW YEARS AGO, TELEVISION, radio, movies, calculators, computers, telephones, and mail service had distinct and separate identities. You could use only one at a time, and you knew what you used each one for each time you used it. You watched television, you talked on the telephone, you listened to radio, you went to the movies, you mailed letters through the post office, and you figured your taxes or budgets on a calculator.

However, the distinct lines between each of these functions that we take for granted have begun to blur, because one machine—a home computer—can do or provide all of these things for you. Today, it can't do all of them cheaply, but it can already do some of them—calculations, communication, and entertainment—more quickly and more cheaply than you can. Tomorrow, the home computer will do all these things for you. The "once and future" computer will take out of your hands many of the dozens of annoying little tasks that waste your time and energy. As a food processor chops onions in a few seconds so that you don't have to chop them for five minutes, a future home computer will reduce the time it takes to do your taxes from hours to minutes.

The home computer will relieve us of a thousand little details of daily living that prevent us from spending our time in tasks we enjoy. A home computer can already relieve you of the annoying task of walking around cold floors late at night to make sure the doors are locked. You can relax in your bed and go to sleep while your home computer automatically locks the doors, turns on a burglar alarm, monitors a smoke alarm, and locks the car door. That application, as you'll see in Chapter 14, costs less than $300 today.

Some computer wizards who like spending money already have $100,000 computerized homes. One man operates a private astronomical observatory on his roof and uses a home computer to turn and adjust it. Another has a home computer system that "watches" his children play in the backyard; through remote sensors, the computer can tell them to return to the yard if they leave it.

Specialized home computers, based on the same computers we've just described, already do these and hundreds of more difficult and different tasks in a few homes around the country. So far, only a few individuals have tried these things. Yet nothing stands between you and a home computer that will do all these things except a little technology, a few smart programmers, and a company with a good vision of what the future can bring. Micro-Age, an Arizona microcomputer and software supply house and retail computer store franchise, has built "Fred the House," a completely computerized display of dozens of things a home computer can do now with inexpensive devices that are available in mass quantities.

These devices, which a home computer will control, will not overwhelm your house or loom menacingly in the corners. They will be part of your wall sockets, or sit inside a drawer, or be built into a kitchen wall. Paul Pimentel, a Massachusetts solar and energy-saving-house designer, has installed a dedicated home computer inside a wall panel in his kitchen. It looks a little

like a large intercom with a small keyboard and a LED clock in its face. Yet this home computer controls Pimentel's home heating and air conditioning system and operates motorized thermal window shades according to a simple computer program. Pimentel says that in mass production, such dedicated units would add less than $200 to the purchase price of a new house.

The Diminishing Computer

In *Alice in Wonderland,* the Cheshire Cat's face, then his body, seem to slowly grow smaller and fade away, leaving only his essential feature, his smile. When home computers start to become as prevalent as the telephone, they will become smaller and smaller, as computer companies pack more and more power into tinier and tinier spaces. The Sinclair Research microcomputer illustrates how small home computers can be made now. Texas Instruments, long a leader in making smaller and more powerful microprocessors, also took a first step toward tiny home computers with its 99/4. Texas Instruments has already delivered magnetic bubble memories with 1 million bits (or 128K bytes) of storage for its 16-bit microcomputer system, the same system on which TI based its 99/4 home computer. TI could easily and quickly incorporate its smaller bubble memories into its 99/4, and it undoubtedly is conducting advanced research on ways to use that much memory in a home computer now. TI has already included a bubble memory in its new language translator. Can home computers be far behind?

Compare that memory capacity to an average program for home computers, which may take up 4,000 and 5,000 bytes (32,000 to 40,000 bits).

Hewlett-Packard and many computer experts foresee the day when a home computer that speaks to you and understands your voice, has a small liquid crystal display screen, and operates through a million-bit microprocessor (and not just memory) will be smaller than a paperback book and will fit into a briefcase or coat pocket.

That pocket-sized computer will not only listen and talk to you, it will also communicate directly through orbiting satellites to any part of the world. National Aeronautics and Space Administration officials have shown, in a 1978 study, how companies could sell Dick Tracy's wristwatch television for less than $100 by 1990, less than ten years from now. These televisions would be based on microcomputers and work through one large 300-foot-wide satellite. The Space Shuttle could, they said, easily put the satellite materials into space, and engineer/astronauts could assemble it in space. The wristwatch TV could also be an interactive computer that would send and receive messages or computer programs. The secret lies in the form in which the signals are sent. Of course, that form would consist of digital bit streams, and one bit stream is much like another. What makes one digital stream into television signals and another into computer programs includes the frequency and size of the signals and, most importantly, the transmitter and receiver that interprets or translates the bit streams back into usable forms.

These futuristic tiny computers were thought ridiculous less than five years ago. At the time, few foresaw the explosion in data communications that is occurring now. And the continuing trend toward miniaturization and the rapid advances in large-scale integration (LSI) of microcomputers have made most serious scientists and thinkers begin to ponder the lengths to which these trends can go.

Dedicated Home Computers

Miniaturization is only one of the ways by which computers will come into your home. So many competitors around the world are carrying out so much research in home and microcomputer applications today that dozens of means exist for the popularization of home computers.

One way has already begun: dedicated home computers. These don't look like the typical keyboard–video monitor–audio cassette re-

corder configuration we've described, and they are not like it. Dedicated home computers are push-button microwave ovens, programmable videocassette recorders, LED automatic alarm clocks, and dozens of new appliances and gadgets. All of them contain relatively simple microprocessors or microcomputers, but they are dedicated to specific purposes. And more dedicated computers are coming into the home every month. They may operate a remote-controlled house, or they may control the amount of water a coffee maker drips on one teaspoonful of coffee (one of these was introduced in 1980). Regardless of the applications, on which only a small beginning has been made, these computers will become more powerful and more involved with helping you carry out your household chores.

See Computer Talk, See Computer Listen

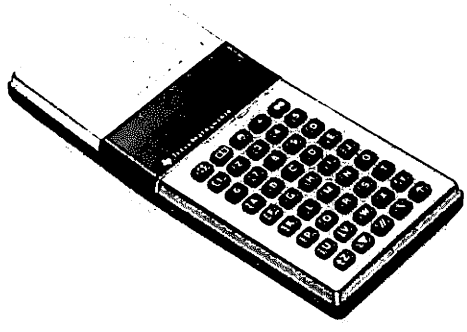
As we noted in Chapter 1, it's highly likely that these computers will both talk and listen to you. Among the companies experimenting now, the Japanese and Texas Instruments have the best chance to introduce such devices within two years. The TI 99/4 already talks to you, and the TI Language Translator speaks to you in a dozen foreign tongues. An owner can teach the 99/4 to learn up to 300 words, and TI has already provided program modules for teaching it up to 800 more words. Less than five years ago, this speech synthesis technology cost tens of thousands of dollars, and only huge computers, which only the telephone company could afford, used it. But TI is selling a sophisticated programmable sound generation controller for a full range of complex musical chords for an eight- or 16-bit home computer for $5 each.

Six Japanese electronics giants—Sanyo, Sharp, Hitachi, Toshiba, NEC (Nippon Electric Company), and Panasonic—have publicly demonstrated voice-controlled home appliances. At an early 1980 Japan Electronics Show, Sanyo displayed a completely voice-controlled computer video game. It has no keyboard at all, but it does have a microphone. One simply speaks into the microphone; the computer does the rest and automatically puts the results on a TV screen.

Toshiba demonstrated a TV set with which you can walk into a room and tell it to turn itself on. The TV set turns itself on *and* repeats your command to make sure it has "understood" you correctly. To raise or lower the volume or change channels, you speak a command and the computer obeys and repeats the command. If you tell the TV to do something it can't do, it politely informs you that you've made a mistake and asks you "please" to give it another command.

Even more fascinating, NEC showed a voice-controlled automobile dashboard that included liquid crystal display screens. Holding a microphone, a driver asks his dashboard, "What is my engine oil temperature?"" The "car-puter" answers through a speaker and displays the same answer on an LCD screen.

Other Japanese companies demonstrated audio record turntables, videocassette recorders, audio cassette decks, calculators, clocks,



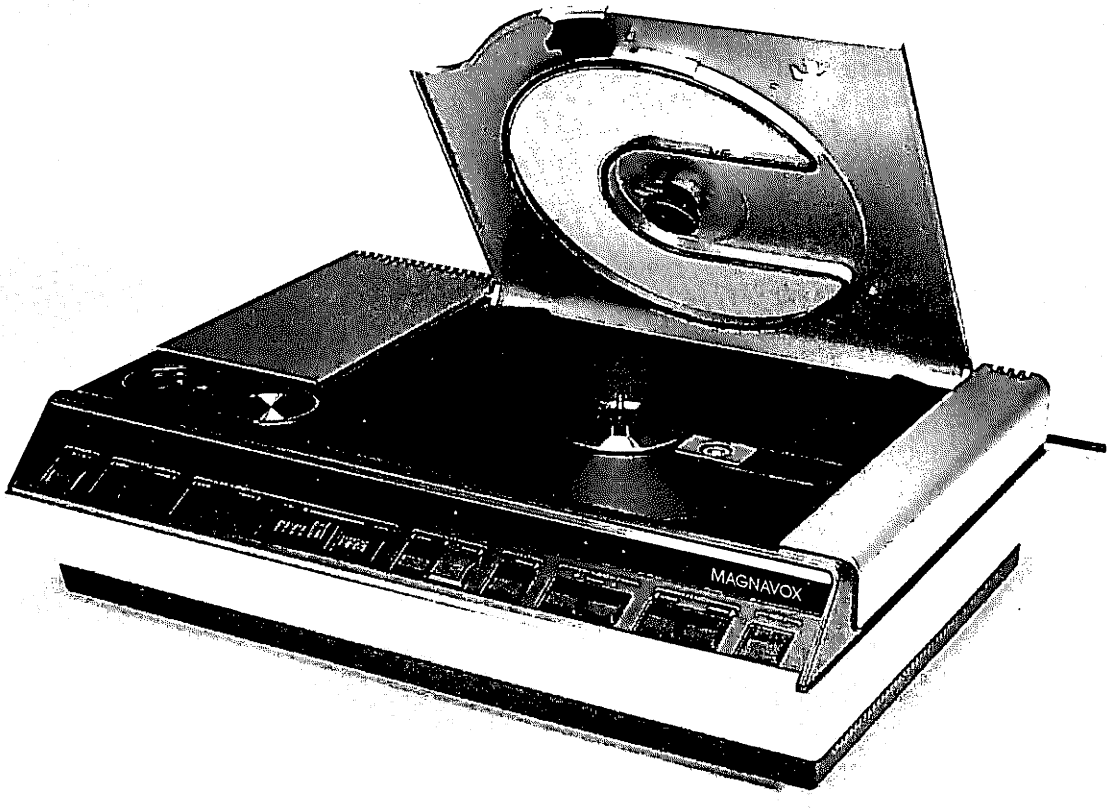
The Texas Instruments talking Language Translator uses Solid State® modules and two extraordinarily powerful 128K-bit ROM chips to produce realistic speech in a dozen languages. Note the speaker at the left side of the unit. (Courtesy of Texas Instruments, Inc.)

and automobile locks run by voice or remote controls, both of which require microcomputers.

As Steve Poe, head of the futuristic communications firm Millennium, in Los Angeles, has said, the Japanese usually demonstrate these products two or three years before they reach the marketplace. By 1982, at the latest, we should see the first of these voice-controlled computers in new home appliance models.

Poe also noted that the same Japanese companies have demonstrated home computers, including a Hitachi model that is scheduled to be sold in the United States in 1981. It has a CRT, keyboard input, digital (not audio) cassette recorder, and a hard-copy printer, all for the U.S. price of about $2,800. Poe found that the Japanese manufacturers seem almost ready to flood the United States with many different kinds of computers. He suggested that this newest Japanese invasion (by late 1981) would include smaller, but more sophisticated and functional, computers and the merger of video games into home computers.

The Magnavox Magnavision video disk player, which plays hard plastic disks that can hold up to 10 million bytes of digital information. In the near future, the video disk market will be for movies and entertainment. But as a computer mass storage system, the video disk has many possibilities. (Courtesy of Magnavox)



The Integrated Video Terminal

The Japanese also have the lead in technology to produce the first integrated video terminal (IVT), but two American companies also have laid the groundwork, according to Ken Bosomworth, president of International Resource Development, Inc. He said that RCA and Zenith have the best chance of introducing a programmable video disk or videocassette recorder (VCR) system in a short period of time. A programmable video recorder would be just one step short of an integrated video terminal. Bosomworth said that people at the high end of the home computer market would most want to buy home computers and videocassette recorders together in an IVT arrangement. In fact, Hitachi has plans to introduce a programmable home computer VCR in Japan in 1981, with introduction in the United States by 1983. The advanced VCRs already have microprocessors in them that allow users to program them for time of day, program channels, and similar functions. Because he has a TRS-80 with two disk drives, Bosomworth said that he would welcome an interface to connect his machine to a VCR.

At this time, VCRs have one significant drawback; video disks have two. Low-end video disk models—such as RCA's new SelectaVision, through which RCA plans to create a billion-dollar industry in two years—and all VCRs have *sequential* recording, rather than random access. If a user wanted to call up a program stored on a VCR that ran for one hour, for example, she could have to wait for 30 to 45 minutes to reach the program she wanted.

Bosomworth noted, however, that a VCR could be made with a short tape loop through which a user could access any part of the tape in five seconds, instead of many minutes. And VCR's enormous band width can store up to ten megabytes (millions of bytes) of digital information.

Perhaps more important, Pioneer Electronics has announced a video disk that uses laser beam technology to play the disk or recall digital information stores on it.

With laser beams, a video disk can scan any portion of the disk in fast-forward, reverse, freeze-frame, slow motion, or frame-by-frame. Most important, the Pioneer Video Disc has immediate (or random) access to any segment or track on the disk. That means that this video disk can be used just like the current floppy or hard disk drives with home computers for a very competitive price. Mini-floppy disk drives cost about $500 and store up to 375K bytes (with double-sided and dual density recording, which has just been introduced). Large floppies, which cost about twice as much, hold twice as many bytes, while hard disks—which cost $4,000 and more—can store up to 20 megabytes. On the other hand, a Pioneer Video Disk would cost about $750 to $1,000 and store more than ten megabytes of information.

However, no video disk, at this time, can be programmed like VCRs, cassette tapes, or floppy disks. David Ahl, a computer pioneer and publisher of *Creative Computing* magazine, says that the technology exists to make video disks programmable. Yet no one has followed through on the needed research to develop it.

Cheap ROMs Fight Back

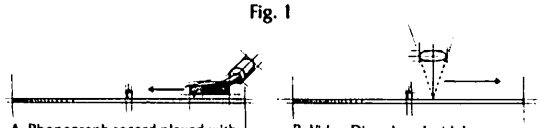
We can expect the computer companies to fight against the VCRs and the video disks with the best weapon they have: the ROM module. Bosomworth and many others look to Texas Instruments Solid State® command modules and the less expensive home computers' program cartridges to provide larger and more sophisticated programs at cheaper and cheaper prices to discourage the use of VCRs and video disks. ROM modules, packed with hundreds of thousands of bits, can, they believe, be sold more cheaply and more effectively than either of the video technologies. They say that, as soon as possible, software houses will provide these dedicated ROMs, similar to the current TI 30K ROM module but carrying 10 or 100 times

HOW DOES IT WORK?

54,000 GLEAMING "TRACKS" PER SIDE.

Since no stylus ever touches the surface of a Video Disc it needs no conventional "grooves" like phonograph records.

Fig. 1



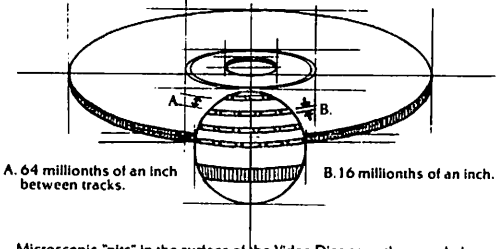
A. Phonograph record played with a standard stylus starts at the outside edge and moves inward.

B. Video Disc played with laser beam system starts at the inside edge and moves outward.

Video Discs are composed of up to 54,000 circular "tracks" that form a continuous spiral from the inside of the disc to the outside - the opposite direction from which a normal record is recorded (See Fig. 1). Each track contains microscopic indentations that look like small "pits" in the surface of the Video Disc player. The number of these pits on each track determines the amount of information that can be stored on any particular Video Disc.

THE PIONEER VIDEO DISC PLAYER- LIGHT YEARS AHEAD OF TURNTABLES.

Fig. 2



A. 64 millionths of an inch between tracks.

B. 16 millionths of an inch.

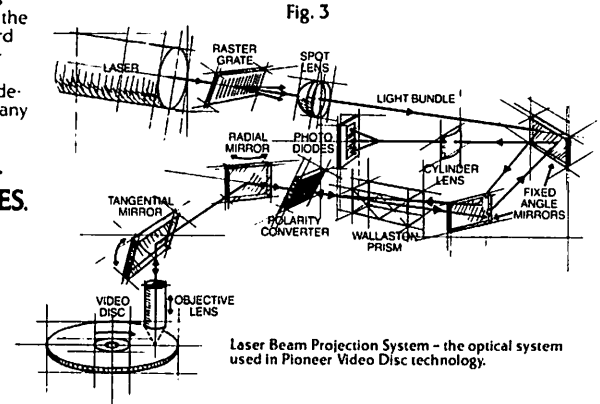
Microscopic "pits" in the surface of the Video Disc carry the encoded video and stereo audio information.

The Pioneer Video Disc player, is, of course, the heart of the entire Video Disc system. It is the "Turntable" and playback device for use with a Video Disc. When a Video Disc is inserted, instead of resting on a platter, it is locked into a spindle, which, while in operation, turns the Video Disc at a speed of 1,800 revolutions per minute. As the laser light beam system moves across the surface of the disc, it picks up the recorded information in the indentations on the disc's surface, and reflects this information back into the system (see Fig. 3).

THE TOTAL PICTURE.

Because Video Discs are recorded in three channels, you get an individual channel solely for the reproduction of the video portion of the disc. And two more channels devoted to audio,

Fig. 3



Laser Beam Projection System - the optical system used in Pioneer Video Disc technology.

for full, rich stereo sound, or independent sound on each channel. The video beam also incorporates a tracking signal into its playing system, which allows it to scan each frame on the Video Disc and perform all the other unique fast-forward, reverse, freeze-frame and slow motion functions the Pioneer Video Disc player is capable of.

The Pioneer VideoDisc operates through optical laser beams, which makes it programmable like a video cassette or video tape recorder. The RCA Selectavision and the Magnavox Magnavision both work with styluses and cannot be accessed randomly. This block diagram explains how the Pioneer optical laser works. (Courtesy of U.S. Pioneer Electronics Corporation)

more programs or information. Exidy, Atari, APF, Mattel, TI, Hewlett-Packard, Sinclair Research, and others already offer simple ROM cartridges, and with the prospect of spirited competition from video memory storage, they will work furiously to upgrade their modules.

Rapidly Expanding Networks

These rapid developments, none of which may happen later than 1983, concentrate solely on how a home computer will become an individual servant. They do not touch on how the second generation of information utilities will transform the home computer. We have discussed the two operating information utilities and computer conferencing through EIES, and we have briefly outlined Teletext, Viewdata, QUBE, and DIGICAST.

All of these just suggest the information utili-

ties that will be operating by 1985. These new networks will serve worldwide groups of users. For example, the nine nations of the European Common Market began a joint system for sharing computerized information from their scientific, economic, medical, legal, and technical libraries. Called Euronet, the network will allow any resident of the Common Market countries to acquire needed information by telephone at low cost. Although at present the Euronet works like a giant reference library, it could easily link its services to simple home terminals or home computers when enough are installed in Europe to provide a healthy base. But consider the cost: each call costs only 12 cents, only 10 cents for each minute of use, and an additional 2.5 cents for each 64 letters of information supplied. For $1, an interested person could spend five minutes on the call and receive about 1,024 letters of information, almost enough to fill one typed page. Euronet obviously makes up the largest personal information network in the world: it serves not only the 260 million people in the Common Market, but also the almost 30 million more in Switzerland, Sweden, Spain, and Greece.

Antiope (the French version of Teletext and Videotext) pages are formatted on a keyboard with a video display showing the finished page. The page is then transferred to a floppy disk where it will be stored for regular, cyclical transmission. (Photo by Donna Foster-Roizen; courtesy of Antiope)

Because Euronet uses the telephone lines, it could be turned into a vast Viewdata network with existiing technology. Yet, in the United States, a vast Viewdata market remains unexplored. QUBE and Viewdata could tap it tomorrow if the Federal Communications Commission agreed. More than 17 million households subscribe to cable television services, and cable television could make dozens of channels available for an enormous range of home computer services. If you have cable television now, you know that many of its channels offer little in the way of 24-hour service. They may run a stock market ticker tape, a news service, or the like on otherwise unused channels. Other channels are blank for long periods of time. No technological problem exists to prevent any cable TV company from establishing an electronic mail service to its current or new subscribers. However, FCC rules and industry reluctance stymied the idea in the late 1970s. But political forces that seek to deregulate cable television and telephone service have recently cracked open the door for these services.

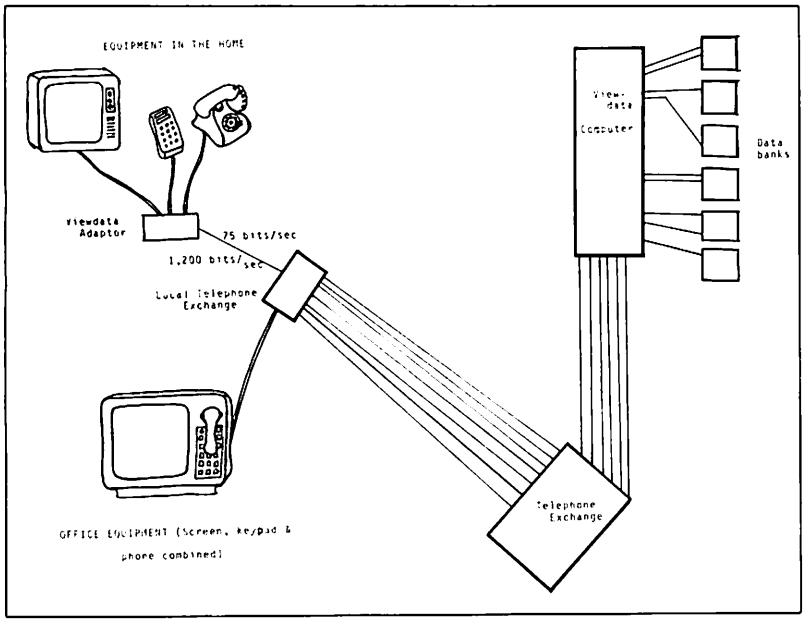
Cable TV companies could offer computer-to-computer conference networks, such as EIES, but to tens of thousands of subscribers. They could act as common carriers—providing a passive channel—for business communications or establish teleconferencing networks. Advances in communications satellites and the so-called "superstations" such as WTCG in Atlanta make the prospects for such networks much brighter.

Satellite technology companies such as Scientific Atlanta build "receive-only" earth stations for less than $5,000. In fact, within the past three years, more than 2,000 cable TV companies have installed earth stations to receive a wider variety of programs, such as Home Box Office, ShowTime, and the Hughes Sports Network. These program originators send signals to RCA SATCOM satellites, which bounce them back to the small, ten-foot-diameter earth stations at the cable stations.

The next step for cable companies would simply involve adding transmitters to their existing set-up and RCA or some other company providing enough frequency space on new satellites, none of which requires any new technology. They do require a healthy regulatory environment and companies bold enough to try it. QUBE has paved the way and shown the cable companies that *interactive* networks can make money. QUBE already has more than half of its 100,000 subscribers in Columbus, Ohio, using the system and willing to pay the price to send responses back to the computer. For a price equivalent to or cheaper than a long-distance phone call, these subscribers probably would want to use the network to send messages or "talk" to their friends or business associates around the country.

The growing competition to develop these networks exceeds anything dreamed of only a few years ago. AT&T and Knight-Ritter's Viewdata test was complemented by AT&T's third largest competitor, General Telephone and Telegraph (GTE), on the other side of Florida. During 1979 and early 1980, GTE engineers at its Telenet (packet-switching service) computer center in Tampa, Florida, experimented with its own Viewdata service. The GTE system used both the regular telephone network and GTE's Telenet packet-switching data transmission network to provide information to GTE's business offices around the country. And, in coordination with GTE, Aregon Viewdata, the British Post Office's marketing arm, has signed up more than 20 major American companies—and information providers, such as CBS, Inc., and the New York Times Company—to both test the Viewdata system and provide data banks which the system can use.

The heart of GTE's experimental system is its Tampa data bank. It receives and stores information supplied by the organizations and transmits information to customers' computer terminals. These business customers operate the system through desk-top terminals with a keyboard and video screen. They can access the



Block diagram of the operation of a typical Viewdata system that would serve both homes and offices.

data bank through the telephone lines (which AT&T provides) and GTE's own Telenet network. The users can receive information in seven colors, and GTE has tested new types of color video terminals. GTE officials plan for this experimental service to evolve rapidly into a completely interactive system providing electronic mail and two-way services for the home.

In fact, GTE has already inaugurated a high-capacity satellite packet broadcasting service to provide electronic mail services for businesses; businesses use the Telenet system to send typed messages and documents such as letters, reports, and texts. The Telenet packet-switching network consists of high-capacity digital transmission lines, which programmed communications processors control through 250 central offices (increased from only 90 in 1979). GTE can now provide Telenet for practically every telephone in the country for the cost of a local phone call. And GTE has equipped its 250 central offices with the first multi-microprocessor packet switches.

To make available enough channels to carry the messages, GTE has incorporated communications satellites, short-haul radio and telephone lines to send transmissions at speeds of up to 1.5 million bits of information per second. That volume increased 27 times in just one year. GTE uses its own earth stations—one at each central office—to communicate with satellites. Each earth station has a "time window," during which it transmits a short burst of data packets to all other sites, and each receives traffic from all other stations and selects the data packets for its own area.

Through these and many other refinements, GTE already offers business the chance to use a new generation of digital facsimile printers, communicating word processors, intelligent copier machines, and other office-of-the-future devices. The first service is its electronic mail service. The new network operates as an electronic mail box, through which businesses can compose, send, and receive messages in "real time," or store them within the network to be called up later—exactly how the EIES network works now. And GTE's electronic mail can also be automatically delivered from one terminal to any number of terminals.

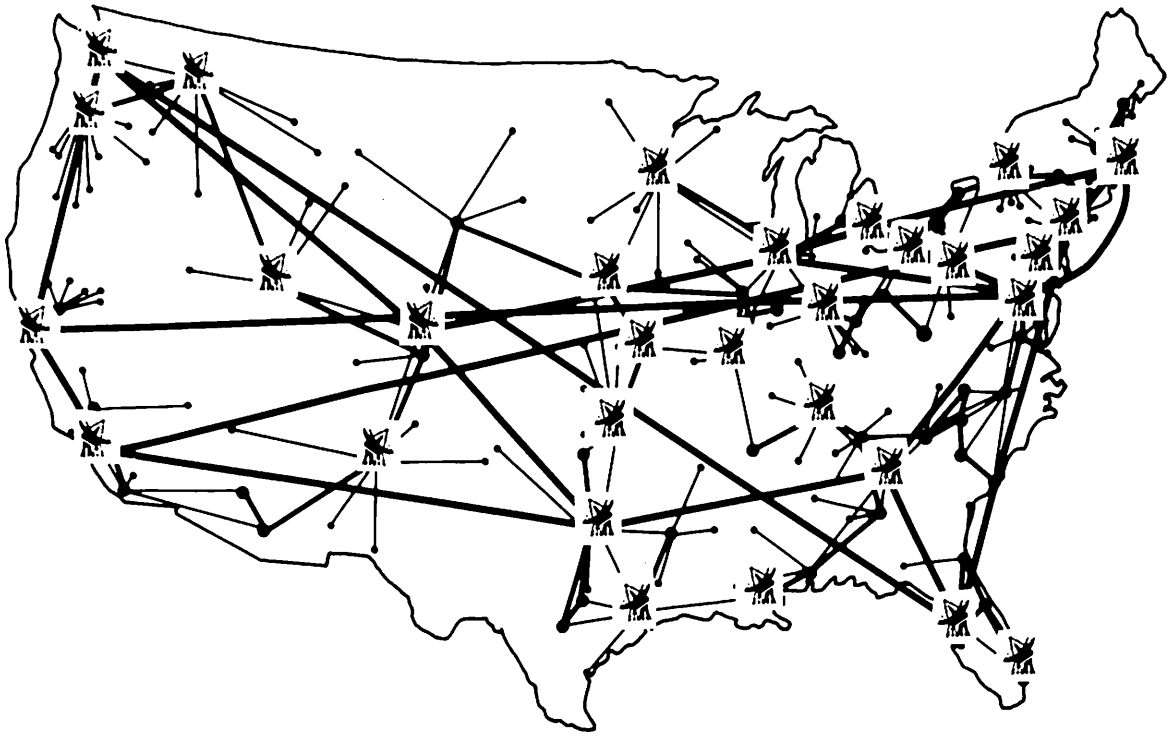


Diagram illustrating the explosion in the size of General Telephone and Telegraph's Telenet data communications network in just two years. The network went from 90 central offices to 250 offices connected by satellite earth stations, microwave transmissions, and regular telephone cables. The Telenet network may form the basis for large Viewdata services within a few years. (Courtesy of General Telephone and Telegraph)

Obviously, GTE could easily adapt all these technologies to a home Viewdata-type system. But other companies are working furiously to provide similar, different, or (they hope) better interactive systems. General Instruments Corp.'s version, called "Televiewy," can work like either Teletext or Viewdata. Basically a Teletext system, the GIC concept can attach Viewdata as an option through a simple telephone modem.

British engineers with the Independent Television Network (ITN) Oracle Teletext system have developed a way to make "dumb" teletext "smart." Operating somewhat like the SOURCE and MicroNET, the Oracle Telesoftware system adds a microprocessor, some RAM memory, an operating system (or control program) in ROM, and several I/O ports, much like any small computer, to turn a regular TV set into a "smart" terminal. Instead of plugging in program cartridges or tapes, however, a user gets programs through the Teletext system. Oracle transmits computer programs in BASIC language along regular Teletext lines to the modified television. Thousands of programs can already be plugged into such a Telesoftware system, and long programs can be sent with no problem because Teletext can merge one "page" of information with another. Teletext companies could easily add more vertical blank spaces in a normal television signal just for transmitting computer programs.

Many experts believe that once such a system uses a good bus, it will accept any number of

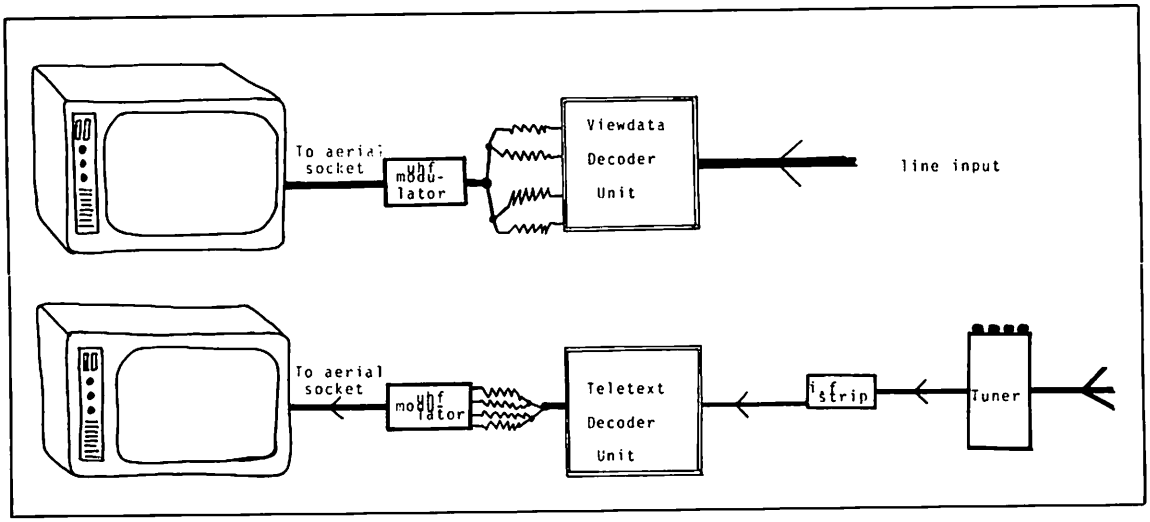
peripherals and make the home television into an ultimate video system.

Of course, the Japanese have not rested on their laurels in Viewdata and networking. They have tested a two-way TV system with a twist. In their video information system, homes interact with a town information center through terminals hooked up to optical fiber cables (telephone or cable TV wires made of glass instead of copper). Consumers exchange information or conduct group discussions through their home televisions and keyboards. More important, Matsushita (Panasonic's parent) has introduced a working model of a color facsimile printer that attaches to a home color TV. Without interrupting a regular broadcast, a person can press buttons on a facsimile machine and receive color pictures or prints of either a picture from a regular broadcast or a picture transmitted over different channels. In this case, the facsimile channel is one part of several channels authorized for stereo TV in Japan.

Clearly, these myriad applications portend a fascinating future of interactive home computing. No one really knows which systems the public will accept. The communications giants, the computer manufacturers, and the electronics wizards of Japan continue to try to find the right formula—and introduce it at the right time—to fit the public's taste. In any case, the next few years will bring a bewildering, but enormously exciting, array of home information services, from simpler yet more powerful home computers, to inexpensive two-way communications networks.

If you, as a consumer, are dismayed by a seeming lack of progress, remember two events: First, RCA committed more than $140 million in 1954—more than 26 years ago—to developing commercial color TV. Ten years later, despite everyone's predictions, less than 3 percent of all homes had color TVs. But, as you know, color TV then exploded as more color programs were broadcast and as color TV prices plummeted. Today, more than 85 percent of all homes have color TV. Second, five years ago, home computers didn't exist. Today, despite experts' dreams, only 500,000 at most are in American homes and businesses. But that number already exceeds the total number of computers in the world in 1973. Again, think back

Block diagram showing how both Teletext and Viewdata services work through decoder units and UHF modulators to produce information on the TV or computer terminal screen. The diagram represents no particular system, just a general concept.



to the early days of TV. TV was being shown in the newsreels and movies in the late 1930s as a curiosity, and color TV was developed in 1939. Yet it took 20 years for half a million TVs to be sold. It has only taken five years to sell that many home computers, and in 1981, that half million should double.

The "chicken and egg" question, which hampered color TV, continues to hold home computing back. But we agree with Ted Nelson, computer prophet and editor of *Creative Computing* magazine. He says that we must seek out ways to make home computers more interactive. He compares the current group of computer people to those in early movies; they know how to build computers and write programs, but they don't know how to design interactive systems, just as movie camera engineers thought they knew how to direct the first movies, but didn't. Computer people, Nelson says, don't understand how to make interactive systems "visual and conceptual," and he believes that interactive home computing will fulfill its promise when moviemakers, graphics designers, and architects begin to design interactive systems with which people can feel comfortable.

He cites the whiz-bang computerized video arcades that anyone can "learn with two quarters" as the clear path toward which home computers must go to succeed. We should take heed of Nelson's two aphorisms: "Using a computer should always be easier than not using a computer," and "The interactive computer screen will be mankind's new home."

Throughout the rest of this book, we shall examine dozens of ways—some good and some not so good—by which people have begun to apply that wisdom to home computers.

PART THREE

What Do You Do with a Mind Machine?

9. Ninety-nine Common Things to Do with a Home Computer

NOW THAT YOU HAVE DISCOVERED WHAT HOME computers are and what impact they may soon have on your life, you may feel as though home computers will dominate you and change you in ways you don't applaud. Let's go back to one of this book's main points: Home computers are no more and no less than all-purpose calculating machines. They are dumb, stupid, inert, and worthless unless *you* tell them what to do. *You* control the machine and command it to do what you want it to do; it acts merely as an electronic slave—though it may not seem like it to someone putting together a computer kit for the first time, but that's no worse than putting together children's toys at 3 A.M. Christmas morning.

What do you want a home computer to do for you? Although you'll find many unique things, let's give your imagination something to chew on and some directions to consider. Before you buy your first home computer, look over this list, and then compare these uses with your own ideas. By the time you are through, you'll be able to answer confidently that nagging question, "What is a home computer good for?"

In this chapter, we'll briefly describe each of 99 common uses, but we can't mention every possible use, configuration, interface, or computer for each use, because the field changes so rapidly. What only one machine could do yesterday, five can do tomorrow and ten the day after.

Games, Simulations, and Animations

1. PLAY PREPROGRAMMED ACTION AND STRATEGY GAMES — Hundreds of game programs are already on the market; game playing was the first popular use for home computers, and it has grown every year. The most popular computer game continues to be Star Trek. Every home computer can play any game that has the right RAM memory and BASIC program. See the Appendix for listings of hundreds of available games.

2. WRITE YOUR OWN GAME PROGRAMS — With a simple knowledge of BASIC, anyone can write his or her own short game programs in a few weeks. See the Bibliography for many excellent books on learning how to program in BASIC. Word and letter guessing games are the simplest.

3. HOLD CHESS, CHECKER, BACKGAMMON, AND OTHELLO TOURNAMENTS — Computer chess probably makes up the most popular adult use of home computers. Personal Software's Microchess program was the first computer program to sell 50,000 copies, and Hayden's SARGON 2.5 is the best one. You can play any of these famous board games against the computer, or use your home computer to play against friends. Computer chess tournaments are very serious affairs at computer conferences, and programmers spend months trying to find ways to beat each other's computers.

4. SIMULATE ECONOMIC AND POLITICAL ACTIVITY — Simulations like Hammurabi and Muse's Three Mile Island put you in the driver's seat, and construct a hypothetical situation that acts as unpredictable as real life. You must juggle dozens of inputs—food supply, population

growth, or nuclear reactor temperatures and pressures—to continue orderly social progress. No easy task, and quite stimulating for adults.

5. MAKE THREE-DIMENSIONAL ANIMATIONS — Programma International provides several interesting programs that demonstrate the principles of animation.

6. DEMONSTRATE ARTIFICIAL INTELLIGENCE — Radio Shack has adapted the famous Eliza program created by Joseph Wizenbaum, which *seems* to act like a practicing psychoanalyst. It works with either Level I or II 16K TRS-80s.

7. CREATE YOUR OWN STORIES — For frustrated writers, Edu-ware Software has Story Teller, one example of how home computers can produce thousands of different stories by combining word menus. Story Teller operates with an Apple II 32K and Applesoft language.

8. TEST YOUR SKILLS IN GAMES OF CHANCE — Other popular programs pit a user against the computer or his friends in traditional games of chance: poker; blackjack; roulette; horse races; go-moku, an ancient Japanese board game; and many others. They're available for practically every home computer.

An average family enjoys a game of Boxing, a pre-programmed action game that can be played with the APF Imagination Machine. (Courtesy of APF Electronics)

9. COMPOSE AND PLAY COMPUTERIZED MUSIC — The Apple II, the Texas Instruments 99/4, the APF Imagination Machine, the Mattel Intellivision, and others emphasize simple programs that teach music to children.

Education and Instruction

10. LEARN REPETITIVE AND MEMORY SKILLS — Home computers are unsurpassed in teaching simple arithmetic with infinite patience. Most home computer makers provide a series of tutorial programs for introductory level mathematics, spelling, and so forth. They also teach more advanced skills, such as typing and speed reading, to teenagers and adults.

11. LEARN COMPUTER LANGUAGES — Radio Shack, for example, provides a series of full-fledged courses in how to learn the different kinds of BASIC, which the TRS-80 Levels I and II use. Other manufacturers and software houses provide instructional and self-teaching programs in more advanced languages such as PASCAL, APL, FORTRAN, and COBOL, or different forms of BASIC.

12. EVALUATE THE EFFECTIVENESS OF TEACHING METHODS — Using a simple home computer, a teacher can evaluate and analyze how effective his tests have been in probing students' knowledge. Dr. Jerry Hering and Douglas W. Green of Cortland, New York, have written a short program in BASIC that performs instant statistical analysis of multiple choice or single-answer tests.

13. IMPROVE CHILDREN'S PERCEPTION — Edu-ware Software and APF, to name two, provide programs that test a child's ability to match lines and shapes with other lines and shapes, and improve a child's memory of perceived sizes, shapes, and colors.

14. LEARN HOW TO THINK LOGICALLY — A computer uses perfect logic in a rigorously structured grammar and syntax. Youngsters may learn how logical thought occurs and how to think in the same manner as they learn to use a home computer.

15. TAKE COLLEGE COURSES FOR CREDIT THROUGH VIEWDATA-TYPE NETWORKS — QUBE has already enlisted four universities to offer college courses for credit on the "QUBE Campus." It bridges the gulf between regular classrooms and passive TV broadcast lessons using many multiple choice questions. QUBE has a small keypad with only five response keys; advanced courses using full keyboards could provide more detailed interaction.

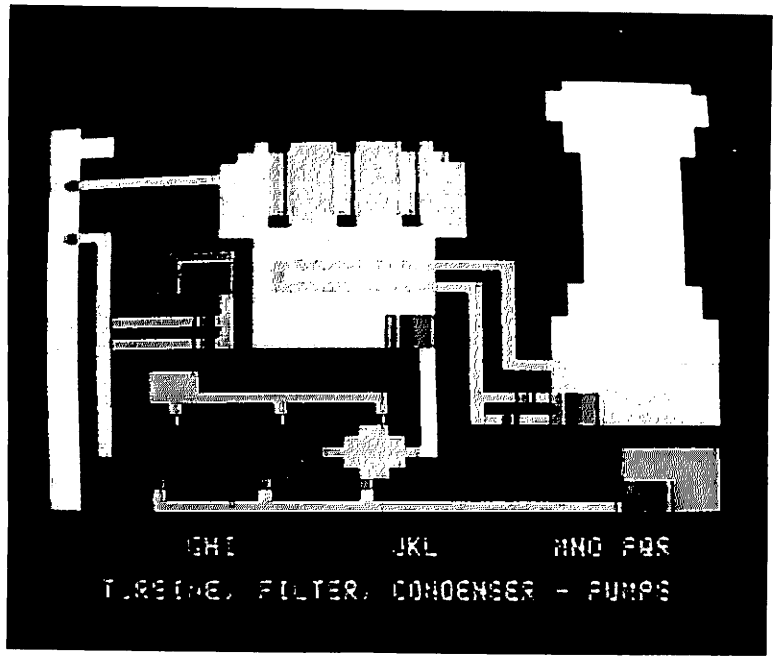
16. USE A HOME COMPUTER FOR SCIENCE PROJECTS AND FAIRS — Any child or teenager, with just a little knowledge of programming, can develop impressive packages to illustrate or solve problems within any area of interest. One 14-year-old Texas youth won a regional science fair competition with a TRS-80 when he simulated architectural designs for lighting patterns in buildings.

17. LEARN ADVANCED MATHEMATICS AND SCIENCE — Ohio Scientific, for example, offers math disks that teach trigonometry, logarithms, metric systems, and advanced sciences, including physics and chemistry.

18. LEARN HUMAN HEALTH AND SOCIAL RELATIONSHIPS — Personal Software, for example, provides six programs for the Apple II, PET, and TRS-80 in the area of human health and relationships, including: "Growing Up," "Drinking and Drugs," "High Blood Pressure," and "Heart Attacks."

Personal Information Management

19. DETERMINE BIORHYTHMS AND CHART BIOFEEDBACK — Many computer magazines have published software to keep track of biorhythms and measure stress and biofeedback patterns. Compucolor Corporation has a dramatic and colorful biorhythm program for its Renaissance Machine.



The intricate arrangement on this picture of a video display illustrates the complexity and "reality" that a simulation can achieve. The picture simulates the turbine, filter, condenser, and pump in a nuclear reactor. It is taken from Muse Software Co.'s Three Mile Island simulation game. (Courtesy of Muse Software Co.)

20. FORETELL PERSONAL FUTURES — Programma International Software sells programs for fortunetelling with tarot cards or the Chinese I Ching. Mattel provides Jeane Dixon astrology programs.

21. MANAGE FAMILY DIETS — More than merely providing a recipe file system, home computers can instantly coordinate each family member's weight and health *and* a family's grocery shopping list with desired weight goals to produce a weekly or monthly menu plan. Mattel offers such a program now.

22. MANAGE THE MODERN KITCHEN — Home computers can create a kitchen directory, act as a family message center, store measurements and conversion tables, and more.

23. ESTABLISH A PERSONAL DATA BASE — Many software houses offer programs that let you establish organized, instantly retrievable files for all kinds of information: from birthdays and anniversaries to the contents of an entire stamp collection. Even better, a home computer can rapidly correlate these facts and produce analyses and comparisons of the worth of various stamps. It will also store descriptions of important documents.

24. ACT AS A PERSONAL SECRETARY — A home computer can perform the duties of a personal secretary and keep track of your appointments, schedules, plans, correspondence, and so on, and remind you—with music, sounds, and/or graphics—when you have to do something.

25. PLAN FOR SOCIAL LIFE AND ENTERTAINMENT — Use home computers to check information utilities for theater, movie, and restaurant guides for your area, and let your home computer keep track of your social schedule.

26. GIVE SHOPPING ADVICE — A home computer can instantly analyze and compare any kind of consumer goods from cars to clothes and apartments to appliances.

27. COMPOSE LETTERS AND CORRESPONDENCE — The computer is a perfect reposi-

tory for all personal mailing lists—Christmas cards, parties, receptions, and so on—and a letter writing and correspondence tool.

28. PLAN HOME IMPROVEMENT — For example, APF's Space, Size, and Surface Guide program calculates all necessary materials and analyzes and compares all prices and costs for home projects such as painting and wallpapering and outdoor projects such as putting in asphalt driveways, lawn seeding, and fertilizing.

Home Financial Management

29. CALCULATE INCOME TAXES — With some programs, such as Mattel's J. K. Lasser's Income Tax Guide program, you can keep track of all expenses, deductions, credits, and so on for federal income tax. Other companies offer sophisticated tax programs for part-time tax return preparers.

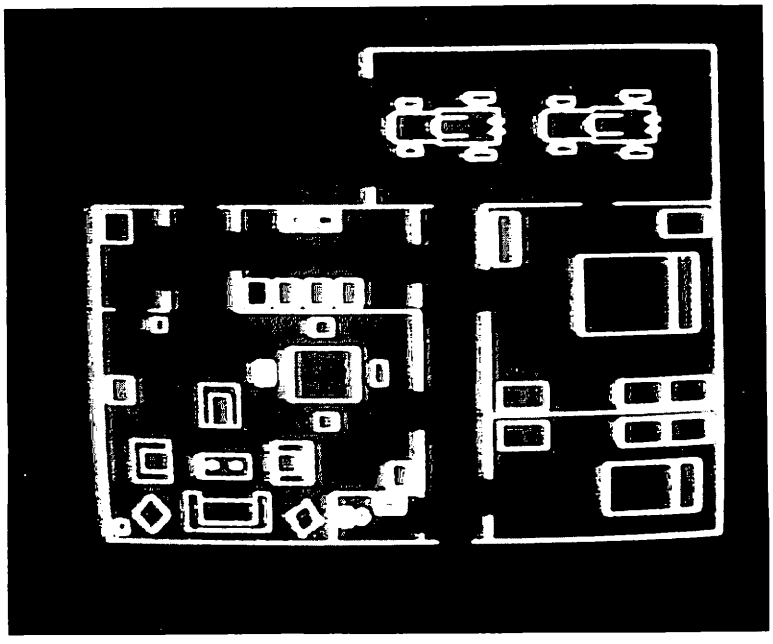
30. COORDINATE FAMILY BUDGETS — A computer can keep line-by-line and running totals of all family budget elements, including expenditures and deposits, and analyze the ups and downs of monthly and annual budget targets. TI's command module is especially good.

31. PLAN HOME PURCHASES — Most home computers can be used to plan all aspects of a home purchase, including mortgage loans.

32. FIGURE LOAN INTEREST RATE COMPARISONS — Home computers can calculate and compare all kinds of interest rates for car, appliance, or any other major credit or installment plan purchase.

33. ANALYZE PRIVATE PORTFOLIOS — If you own one stock or 1,000, home computers will instantly plot the progress—or lack of it—for all stocks, bonds, options, commodities, and so on with the Dow Jones Stock Quote Reporter, the SOURCE, or MicroNET. You can get instant updates for any of 30,000 issues.

34. PLAN PERSONAL ESTATES AND RETIREMENT — Most home computers have programs that can project retirement income, an-



The interesting detail shown in this picture of a video screen demonstrates how easily and effectively a homemaker or a designer can use home computers for room redecorating and arrangements. The screen illustrates the capability of Muse Software's U-Draw II graphics program, which works with an Apple II computer. (Courtesy of Muse Software Co.)

nuities, and savings and pension plans and coordinate results with personal investment and retirement goals.

35. MAINTAIN PERSONAL CHECKBOOKS — Much faster than you can whip out pencil and paper, a home computer can do checkbook trial balances and reconciliations, and remember years' worth of checkbook entries—deposits and checks cashed.

Computer Graphics

36. DESIGN ANYTHING — With a graphics plotter, such as the Apple Tablet or the Cromemco Superdazzler video board, anyone can design new clothes, new rooms, new gardens, and new landscapes or plan a complete home redecoration.

37. "PAINT" COMPUTER PICTURES — A home computer creates a new kind of art anyone can do; computer art is dynamic and can change and take on new expressions. Almost all home computers have at least simple computer art programs.

38. ILLUSTRATE MATHEMATICS — Home computers with color can create dynamic, high-resolution graphics that illustrate how algebra, trigonometry, and geometric formulae take shape in the real world.

39. DISPLAY TV PICTURES — Using a home video camera and a home computer, you can display slow-scan television pictures in high-resolution graphics on the screen.

40. DRAW HOBBY ELECTRONICS CIRCUITS — Home computers can aid the electronics or electrical kit buff by drawing audio, hi-fi, stereo, or other electronic circuitry.

41. CREATE HIGH RESOLUTION KALEIDOSCOPES — A home computer, especially the Apple II 32K model, can create an infinite variety of color kaleidoscopes in an endlessly changing cycle for a kind of "living" art.

42. PROGRAM BAR GRAPHS — For any purpose—from displaying the ups and downs of stocks to home budget categories—any home computer will create and display a variety of curved and patterned graphs.

43. DRAW WITH LIGHT PENS — With an electronic pen, you can draw on a home computer anything you want, from lines and boxes to complex pictures. These inexpensive light pens have caught the fancy of many young children.

44. SET UP A MOVING SIGNBOARD — If you want to make sure your children get an important message, your home computer can act as a moving billboard that will certainly catch their attention.

Home and Small, Small Business

45. ANALYZE CASH FLOW — In inflationary times, cash flow makes or breaks any home-based or small business, and home computers let you track cash flow on a daily, weekly, monthly, and annual basis in minutes.

46. CONTROL INVENTORY AND STOCK — Even door-to-door saleswomen may need to keep precise control of their inventories, and a home computer can do it for a product line with 10 or 10,000 items.

47. GENERATE COST REPORTS — Home businesspeople often overlook how much doing business actually costs them. A home computer can present an accurate and complete picture of exact costs in seconds.

48. ANALYZE MARKET SURVEYS — Even a small home computer can quickly summarize market surveys or opinion polls of up to 100 people who are asked a dozen questions, a function useful for polling PTA or nonprofit volunteer groups or a home business's clientele.

49. PERFORM ACCOUNTING SERVICES — Every home computer company has written

packaged programs to perform small business accounting.

50. DO WORD PROCESSING/TEXT EDITING — Every home business must send out correspondence of many kinds, and a simple word processing program and a printer can save 50 percent of your drafting and editing time.

51. MAINTAIN GENERAL LEDGERS — Many home businesspeople can adapt home budget management programs to act as general ledgers for their business functions, or they can buy inexpensive general ledger software.

52. KEEP ACCOUNTS RECEIVABLE — Home computers can keep accounts receivable separate and integrate them into an overall general ledger.

53. KEEP ACCOUNTS PAYABLE — Like the above, home computers maintain separate accounts payable reports and combine them with others.

54. KEEP PAYROLL AND PERSONNEL RECORDS — Anyone with part-time or occasional employees or family member employees, or who is self-employed, can use a home computer to do all payroll, taxes, deductions, contributions, and so on in minutes, compared to the hours it requires by hand. This is especially helpful when paying quarterly employment tax bills.

55. MAINTAIN EXTENSIVE MAILING LISTS — Door-to-door or party plan salespeople need a fast, efficient home computer to maintain mailing lists by name, address, zip code, block, phone number, or other category.

56. ESTABLISH INDEX CARD FILE — Many businesspeople keep extensive reference or index card files. They could enter all the information on home computers and have it instantly retrievable by any category they wanted.

57. SERVE PRIVATE INVESTORS — Private investors can combine several programs and have instant updates and continuing analysis of all portfolios.

58. PLAN INSTALLMENT SALES — Small retail stores that offer installment plan sales can tighten their installment sales controls, maintain accurate records of all installment sales and determine future cash flow from such sales with a home computer.

59. TRACK SALES CALLS — Traveling, part-time, or commission salespeople can keep track of all sales calls, analyze their territories, and more effectively plan sales travel and strategy with a home computer.

60. KEEP SALES EXPENSE/BUSINESS ENTERTAINMENT/BUSINESS TRAVEL RECORDS — Instead of having to deciper a scrawled expense notebook or calendar at tax time, anyone with deductible expenses can enter all of them into a home computer once a week or month and, at the end of each quarter and year, receive an instant total and analysis.

Professional Applications

61. KEEP PATIENT HISTORIES — Doctors and dentists can keep all their patient histories and files in home computer memory, and break them down by category—age, sex, health conditions, illness, cavities, fillings, and so on.

62. ANALYZE REAL ESTATE INVESTMENTS — A home computer can quickly tell a part-time real estate investor the best deal for any prospective purchase.

63. MANAGE INCOME PROPERTY — Many software houses now have programs with which you can manage apartment buildings or other income property and determine rates of return, depreciation, appreciation, and so on.

64. ASSIST ARCHITECTS — As we saw in the graphics section, home computers can do detailed architectural drawings and renderings of anything an architect wants to look at.

65. ASSIST ENGINEERS — Dozens of programs exist to help any kind of engineer with statistical analyses, measurements, and so on.

66. CROSS-INDEX LITERATURE — Doctors, lawyers, dentists, or any professional who needs to keep up with professional reading can use a home computer to cross-index professional literature and reference materials according to categories of his or her own choice.

67. "SENSE" PATIENTS' ILLNESSES — One doctor has added sensors to a home computer system and babies' cribs. If a baby makes odd movements, the sensors signal the computer, which sounds an alarm. This idea could provide great assistance to home nurses who must aid stroke victims or handicapped persons.

68. MAINTAIN ATTORNEYS' CASE FILES — Attorneys are using even small-screen home computers like PET to process case files, store and recall standard contracts, write and edit briefs, and other legal tasks. Any word processing system is appropriate for this application.

69. CALCULATE STATISTICS — Statisticians and other mathematics-related professionals can use home computers to speed their computations and comparisons using advanced math programs available for the PET and the Apple.

70. MEASURE AND CALCULATE ENERGY-SAVING/SOLAR HEATING APPLICATIONS — As we've noted, solar designers and air conditioning and heating professionals are using home computer microprocessors and graphics to design and operate home systems. Homeowners can use them to calculate heat loss from windows, doors, attics, and so on and determine how much insulation to install for maximum savings at the lowest cost.

71. PERFORM TEACHERS' AND PROFESSORS' GRADE RECORD-KEEPING AND STATISTICAL ANALYSIS — Any teacher, regardless of level, must keep substantial and accurate records for all of his or her students; home computers can act as an instant record-keeping and referral service for every grade, fact, or impression that can be expressed in words and can provide instant grade averages, means, modes, and medians for all of a teacher's classes.

Home Controls

72. CONTROL LIGHTS WITH PREPROGRAMMED TIMING — As you'll find in Chapter 14, controlling all of your lights with a home computer and an inexpensive system is the cheapest current home control use.

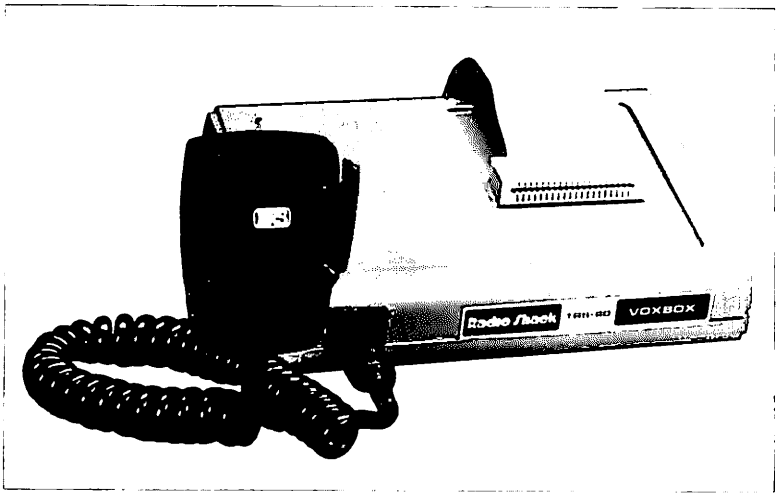
73. MONITOR WIRELESS REMOTE CONTROLS — Ohio Scientific's Challenger C8P DF machine will control—through remote control—car locks, garage doors, and other locks.

74. OPERATE HOME SECURITY SYSTEMS — The C8P DF will also control fire, smoke, and burglar alarms. Other systems can do the same thing relatively inexpensively.

75. SENSE REMOTE AREAS — With off-the-shelf sensors and a home computer, you can let the computer watch your children at play, providing perimeter security, and tell you when the lawn needs watering—or turn the sprinkler system on by itself without bothering you. It can also defrost your frozen or snow-covered driveway through simple coils and wires laid in the concrete—and it can do it during a storm, before you get home.

76. OPERATE HOME HEATING AND AIR CONDITIONING — Like Paul Pimentel's new solar and energy-saving house, any home computer can work through controls and sensors to raise or lower heating or air conditioning, thermostats, heat pumps, solar systems, hot water tanks, oil burners, gas heaters, electric heaters, and any kind of energy device in the home.

77. REGULATE ALL HOME APPLIANCES — Using the Ohio Scientific system or the X-10 controller marketed by Radio Shack, Mountain Hardware, and others, you can program your home computer to turn on or off any home appliance, which is an excellent way to save energy if you use appliances at off-peak hours.



The Radio Shack TRS-80 Voxbox® allows TRS-80 owners to experiment with simple voice recognition. the Voxbox can learn to speak up to 32 words, all of which the user chooses. A TRS-80 Level II with 16K RAM and cassette recorder are required, and a machine language program, three demonstration programs, an owner's manual, and a microphone come with the unit. (Courtesy of Radio Shack)

78. RUN A TELEPHONE-ANSWERING SERVICE — A home computer can not only work like an answering machine, it can also act as an automatic dialer tied to security and safety systems.

79. CHECK AND PREDICT WEATHER — Attach a home computer to a Heathkit digital weather station, and it will instantly monitor temperature, pressure, and so forth and indicate future weather conditions.

80. CONTROL A HOME MESSAGE CENTER — A home computer can replace written bulletin boards or reminder pads, and be programmed to hold all personal and family information.

Voice Recognition and Speech Synthesis

81. LEARN CONVERSATIONAL FOREIGN LANGUAGE SPEECH — As we've discussed, Texas Instruments and Mattel's machines will teach you conversational French and German.

82. VOICE CONTROL OF HOME CONTROLS — Using an inexpensive Speech-Link voice recognition system from Heuristics, many hobbyists have enabled their computer's home control systems to recognize spoken commands.

83. INFORM, INSTRUCT, QUESTION, AND PROMPT — Talking computers, such as Texas Instruments' 99/4, use advanced speech synthesis to respond—in English—to your typed-in commands or your answers to the computer's questions.

84. ANALYZE VOICE PRINTS — Inexpensive microcomputers already perform voice print analysis for security devices.

85. ACT AS TEACHING AND BABY-SITTING AID — A talking computer could be programmed to prompt young children as they learn to read or do math, or tell the babysitter not to raid the refrigerator.

86. AID THE HANDICAPPED — As we'll see in Chapter 13, home computers already enable crippled, paralyzed, or physically handicapped persons to communicate through terminals with the twitch of an eyebrow, the touch of a finger, or the slightest movement of the head. Talking calculators are already available.

Music

87. LEARN HOW TO READ MUSIC — Most simple home computers already have programs that teach children how to read music and encourage them to compose simple songs.

88. LEARN MUSIC APPRECIATION — Advanced programs for adults can teach music history and music appreciation through sound synthesis.

89. LEARN BASIC AND ADVANCED COMPOSITION — Many clubs and societies, such as the Computer Music Society in Philadelphia, already encourage home computer owners—especially music professionals and interested amateurs—to hone their skills through advanced music programs.

90. COMBINE COMPUTER MUSIC AND ART — Many entertainers are experimenting with home computer-controlled color/light and sound shows to create unique forms of entertainment, and beginners can practice the same techniques with computer music synthesis and computer art displays on a screen.

Odds and Ends

91. OPERATE HAM RADIO NETWORKS — At the 1979 Personal Computer Festival, ham radio operators demonstrated how to run a ham radio network with an inexpensive home computer.

92. TRACK SATELLITES — A computer magazine recently printed a program that allows you to predict when and where the next satellite will fall to earth. Beware of Skylab II!

93. INTERFACE LANGUAGE TRANSLATORS — Craig and Nixdorf have demonstrated the RS-232 interfaces so that you can hook up their language translators to your home computer.

94. CONTROL TV CAMERAS — Advanced hobbyists use their home computers to display TV pictures from their color video cameras.

95. PLAN TO BUY A NEW HOME — Although some programmable calculators run programs that quickly figure mortgages, a home computer can compute a whole range of home-buying variables in less time. A home computer can also accept dozens of variables, such as mortgage amount, monthly payments, property taxes, personal tax bracket, insurance and upkeep costs, general inflation rate, comparable rent, rent savings, down payment, and so on. Unlike a calculator, a computer can then "digest" all of these variables and instantly gauge each one's effect on the overall picture. By hand, or using a calculator, it would take hours to do the same analysis a home computer can do in minutes.

96. CREATE YOUR FAMILY TREE — You can interact with a network of genealogists or develop your own family tree through a home computer. Many magazines have published genealogy programs, too.

97. LEARN AMATEUR ASTRONOMY — With a home computer, you can track the stars, predict eclipses, program your own "heavens," and learn astronomical techniques.

98. ORGANIZE CAR POOLS — Three San Francisco computer store employees used an Apple II to help alleviate traffic congestion in 1979 after a fire knocked out a new mass transit system: they organized car pools with its help.

99. RUN HOUSEHOLD ROBOTS — Home computer "brains" can easily run a household robot, such as a tiny learning aid and toy called Terrapin. You can also build your own robot for a few hundred dollars.

These 99 things to do with a home computer only scratch the surface of the thousands of things happy home computerists do with their all-purpose pleasure machines every day. So let your imagination soar, and enjoy your computing.

10. The Three Rs and a C

PEOPLE LEARN BY DOING, whether the task involves learning how to add and subtract or how to program computers in machine level languages. Home computers provide an extraordinarily promising way for everyone to learn whatever they want to, even though they may experience it only vicariously on a home computer. As one computer expert has said, if experience is the best teacher, then pseudo-experience is the next best teacher. A child can listen to a teacher explain how to add or subtract, and define what addition and subtraction mean, but a child will not *know* what addition and subtraction really are until he or she manipulates the numbers, an act a computer can help a child to do.

A home computer can act as a teacher in the home for practically every aspect of a learning experience. It may show a colorful display illustrating what addition and subtraction mean, it may display the process of adding and subtracting, and it may allow a child to interact and actually experience manipulating numbers and understanding what addition and subtraction really do. Of course, a simple example such as elementary arithmetic merely introduces the power of a home computer in educating your child and you.

When a person buys his first computer, perhaps a simple, inexpensive model, he immediately discovers what may be the most important fact about computers. This fact often becomes obscured in the distracting excitement of lights, sounds, and captivating displays, but it concerns the fundamental nature of an computer. Simply, computers must operate through *logic,* a precise, ordered set of operations that cannot be changed without causing the computer to malfunction (or fail to execute your commands). For example, the most common example given about programming computers begins with the line: *PRINT "HELLO."* If you don't type in that line exactly as it's shown, the computer cannot understand the instruction and will flash an error message. If you don't exactly follow the "grammar" of computer language, it can't understand you. This fact becomes especially apparent—and often annoying—when you begin to learn programming. In short, a computer uses perfect reason.

This perfect grammar and reasoning ability may seem like a minor tyranny, but, in education, especially of young children, a home computer can help them rapidly and thoroughly learn how to think. Young children, often those just learning to read, take to computers like a duck to water. It seems that children inherently want to learn, and enjoy learning, logically. Some people may object and say that children like home computers because of the exciting games, sounds, and colors. But that viewpoint doesn't explain why and how many children quickly learn programming—often difficult and complicated languages—at an early age (10 or 11). Learning programming requires a great deal of straightforward thought with very little "bells and whistles" excitement until a program is completed and runs perfectly. The first drafts of programs often fail, as any professional programmer will agree, and getting a perfect work-

able program often requires repeated refinements. Yet hundreds of children are learning to program in fluent BASIC. And they are leaving adults with little training in logic and no training in computers far behind.

In fact, parents have been motivated to buy computers to learn about computing and computers. One professional programmer who bought a TRS-80 for his children has said, "I wanted to educate my family about computers because of the importance they'll have in everybody's lives." That importance, as we've seen, stretches far beyond the bounds that most people have even begun to consider. Home computer, or computers based on the same microcomputers and their smarter descendants, already inhabit more than 750 common devices, and new ones—from home appliances to solar heating to automobile engine blocks—arrive practically every day.

Besides this virtue, it seems that the sooner children and young people learn to think, and think with logic and rationality, the better students and adults they will become. With its em-

This father and son are learning to program the Texas Instruments 99/4 Home Computer together in a scene that is being repeated in thousands of homes, as children and parents use their home computers for educational purposes. (Courtesy of Texas Instruments, Inc.)

Every member of the family gets in on the act when parents bring home a microcomputer, such as the Radio Shack TRS-80 Microcomputer System. Parents often find that they learn as much as their children from the computer's logical and orderly grammar and structure. (Courtesy of Radio Shack)

phasis on logic, grammar, and rational structures, home computer-based education could even reincarnate what used to be considered a "classical" education.

Experts who devote serious thought to future home computer applications believe that long after every small business already has its own microcomputer running its general ledgers, word processing, and inventory systems, parents and children will still be discovering new ways to learn to use home computers.

At present, education with home computers—whether in the school or in the home—can be divided into four broad areas: 1) repetitive learning and skills training; 2) simulations; 3) thought exercises; and 4) problem-solving exercises.

Any parent or child can start using these kinds of learning exercises with their home computers right now. Every home computer manufacturer listed in this book has produced a selection of packaged educational programs. (See Appendix.) And each promises that it will continue to emphasize new educational programs for everyone in the family. For example, Atari, Inc., is working with Science Research Associates, Inc., an established home computer software company, to provide "courseware"

programs for reading, language arts, mathematics, science, and social studies for what Atari calls "a fast-growing area in the personal computer field."

The professional programmer proved how fast-growing it could become: His 12-year-old daughter wrote a talking calculator program that allows a blind person to communicate through a TRS-80. She used a TRS-80 Level 16K with a disk storage drive, a speech synthesizer, and a printer. The synthesizer allows the teenager to teach the computer to imitate human speech.

Another teenager also proved the principle when he combined his new knowlege of programming with a desire to learn at home. At the age of 15, he prepared for school history tests by programming important facts and dates into a home computer. He tested his knowledge by answering questions he'd included with the program. This teenager's younger brother writes his own programs, too. Their father, a successful toy designer, has said, "They can program better than I ever will. To them it's like learning to speak a foreign language."

Children first learn how to use computers by playing games, and most home computers provide exciting learning games that tutor in grade level math and spelling. Texas Instruments, Mattel, APF, and many manufacturers of electronic hand-held games combine colors, sounds, and music into simple learning exercises.

These exercises seem to keep young children interested for longer periods of time than a classroom or homework exercises would. One teacher discovered that his first-grade daughter spent more time solving addition and subtraction problems with a home computer than she had ever done with pencil and paper.

A home computer can provide an endless number of math or spelling problems for any level if it has the proper program. It is the perfect vehicle for individualized instruction, an important concept in modern education. It never gets tired, leaves the room, changes the subject matter, looks after 125 other students, or goes too fast for slow learners or too slow for fast learners. And any parent with a little knowledge of programming can write these simple tutorial programs, or type in any of dozens of educational and tutorial programs in the public domain found in magazines or books. Each year many computer magazine publishers issue a collection of programs, and many often include educational uses.

Tutorial programs can also apply to any other level of learning. Practically every subject requires a student to spend some time in repetitive exercises, because each subject has fundamental principles. Home computers can teach these principles regardless of the subject matter. After all, the computer doesn't get confused if you enter an advanced calculus program; it just accepts the information as binary (logical) digits.

Simulations

Many dangerous and essential professions—jet pilots, nuclear power plant operators, oil tanker captains, astronauts, and subway traffic control operators, to name a few—cannot use on-the-job training without endangering other people. So, in the past two decades, huge, complicated, computerized machines have trained people with very realistic simulations of the actual conditions they will face on the job. These simulators have proved enormously successful with many other industries, too, including oil refineries, adopting simulation training.

In business and education, role-playing exercises have become popular in training new supervisors or improving managers' skills at professional seminars. These exercises also simulate the real job, but without computers. Universities, "think tanks," and economic forecasters use complicated computer models to predict future economic, social, political, and cultural conditions. These, too, are simulations.

You don't need a professional seminar or ex-

pensive computers to learn through simulations. The second most popular kind of computer game is the simulation game. Muse Software has introduced an extraordinary one, called Three Mile Island, which works on an Apple II computer and portrays the actual operation of a nuclear reactor in vivid, scary color. The demanding simulation game tests the player's skill at maintaining rapidly changing temperatures and pressures and solving emergencies—which appear randomly or as a result of a player's mistakes. Other inexpensive commercial programs simulate population explosions and population control and economic and social challenges, in which a player acting as "king" or "queen" must maintain balances among supplies and demands for food and other necessities. Other programs simulate pilot training and air traffic control.

Someone with a moderate knowledge of programming can easily develop his or her own simulation games, using instructions in pro-

Children and teachers find home computers, such as the TRS-80, make repetitive exercises and drills more exciting and more fun. Children often spend far more time with these skill exercises when they are using a home computer, many teachers have said. (Courtesy of Radio Shack)

gramming books, such as Thomas A. Dwyer and Margot Critchfield's *BASIC and the Personal Computer.* They devote an entire chapter to learning how to prepare simulations.

Any real-life situation or occupation can be simulated on a home computer, and any simulation can provide challenging ways for children and adults to learn. (If you think simulation games are kid stuff, try Three Mile Island at your nearest computer store.)

Home computer education doesn't leave out the adults. Software companies are just discovering the demand for adult education programs. Adults can use home computers in the same way they have always used correspondence courses, weekend classes, or night school. One company has released a series of BASIC cassettes that offers a complete self-study course in real estate, and an adult can use the programs to prepare for a real estate broker's license examination. Another company has a Teach Yourself by Computer series that combines computer program tapes with instructional booklets. As the home computer market grows, interactive home study courses for every adult career or profession will appear; thousands of people already listen to self-study or self-improvement tapes prepared by professional organizations in place of or as complements to printed books. Computer owners will find it a short step to go from listening to tapes to interacting with a home computer program on tape. The home computer may well do a better job—after all, you can't look in the back of the computer to find the right answer as you can when you use a home-study book.

Learning Programming

After games and simulations, the most popular educational way people use home computers is in learning computer programming. Many people buy a home computer without the slightest intention of learning how to program in BASIC, but often discover that to develop a home computer's full potential they wanted to learn programming. That situation has changed and will continue to change rapidly. You don't have to know BASIC, but most people would do well to take the professional programmer's advice and use a home computer to learn about computers and programming. Nothing will make a computer less frightening than wrestling with the dumb thing and winning—that is, writing your first perfect program.

Dozens of books and hundreds of program tapes and disks are available to teach you BASIC, all of its variations, and any of a dozen or more computer languages, including each individual microcomputer's unique machine and assembler languages.

The Bibliography at the end of this book lists many of these books and the Appendix lists many of the tapes or disks for each kind of home computer mentioned in this book.

David Ahl, publisher of *Creative Computing* magazine, and authors Donald D. Spencer and Ted Sage, in particular, have developed an interesting way to learn programming: they go back to square one and teach BASIC through games. They prefer games and humorous problems and puzzles to mathematical algorithms and strict exercises as learning aids.

In the Near Future

Texas Instruments introduced the educational home computer of the future in 1978 with its Speak 'N Spell game. This $50 game packed more ROM memory onto a silicon chip—128K—than any other chip at the time. In fact, the game had two chips, both of which were used to synthesize speech. The game pronounced words, some easy and some tricky, and asked the child to type in the correct letters on a simple, one-line keyboard. If the child typed the correct answer, the game spoke words of praise and played a pleasant little tune; if he or she was wrong, the game gently corrected the mistake. The game's first module contained 140

words, and TI has since introduced several new modules so that any child can learn to spell more than 750 words of all levels of difficulty.

Texas Instruments' 99/4 home computer has the same capability and much more. It uses speech synthesis in all its educational command modules. All simple talking tutorial programs, at least those for young children, seem to be headed in the same direction.

For older children, teenagers, and adults, QUBE, Viewdata, and EIES information networks hold the key to the future. As we noted in Chapter 9, QUBE has already established "QUBE Campus" in Columbus, Ohio. Through the campus, adults can enroll in college courses at one of four local colleges or universities and take college-level courses for credit over a QUBE channel. Each QUBE subscriber has a two-way adapter on the TV set that lets him or her respond to the television program using five response keys on a keypad. The college instructor can take attendance by asking those enrolled in that course to "touch in," and the QUBE computer can tell the instructor exactly who is watching the lecture.

An instructor can ask the TV class multiple choice questions and the students can key in one of five responses on the keypad. When they've replied, the computer flashes the correct answer and tells which students chose which answers, or an instructor can ask one student—sitting at home—a direct question and the student can key in a single response.

One woman, who had only two years of college, divorced after having two children. She tried going to night classes, but the pressures of a full-time job, the children, and studying proved too much. Instead of quitting, as she had done when she married, she signed up for the QUBE course, and now plans to take as many QUBE courses as she can before she returns for her degree.

QUBE hasn't stopped at introductory college curricula, however. It also offers selective education—classes for professionals who need special information. The first selective education class was an "update" class for physicians. QUBE also offers self-help and self-improvement education, including beginning shorthand and golf. Subscribers key in their choice for each class session and are billed a small charge—75 cents or $1—for each lesson.

QUBE obviously has limited potential compared to EIES and similar computer conferencing networks. EIES has already allowed advanced professionals to prepare research and academic papers and books together although they were separated by thousands of miles and never saw each other.

The potential of conferencing networks could be enormous, when the price approaches the cost of a phone call. Network subscribers could provide involved, detailed answers to professors' questions instead of one-symbol answers to multiple choice questions. They could carry on detailed classroom discussions about any subject, including subjects such as writing and composition. They could share, discuss, or jointly write poetry, plays, short stories, or even novels, or work out complex mathematics problems—with the same home computer they use as a network terminal. EIES could work with any of the dozens of methods that comprise traditional classroom instruction. Using EIES or other networks for so-called classroom education means that not everyone has to sit in class at the same time. Students could participate at their leisure within time limits. That would have helped me make better grades in college; I never *could* get up for my 8:00 A.M. classes.

In this brief discussion, we have barely scratched the surface of the rapidly developing potential for home computer education. And no one knows what new forms of educational methods will evolve through the home computer.

For now, however, parents may consider the advice of the teacher who began teaching his first-grade daughter with a home computer. He believes that many people easily tire of their

new home computer and treat it like a Christmas toy. Once they play too many games, or run out of money for exciting peripherals, they let a home computer gather dust.

He advises, instead, that parents can keep their home computers "young and active" by giving them some contact with and letting them help young children. He notes that the parents who have seen his simple BASIC programs, and how they have helped his daughter, go away saying, "That could be just the thing for our child." An imaginatively used home computer could be just the thing for you and *your* child.

11. Division of Labor: Home Computers in Your Work

TENS OF THOUSANDS OF SMALL businesses—from part-time salesmen to owner/executives of million-dollar companies—have bought home computers in the past three years as they sought new ways to overcome the handicaps that every small business faces: too little time; too much paper work; too much to do without enough help; and so on, down a long list of adversities.

Accountants have looked to home computers to lessen dramatically the time they spend on paper work and calculations; lawyers want home computers to speed up the processing of briefs and standard contracts while lowering secretarial costs; small printers want faster scheduling of their shops' jobs; consulting engineers want faster means of sketching initial construction blueprints and calculating bid estimates; in fact, any small business owner, whether the sole employee or a president supervising several dozen people, can find uses for home computers that can save him or her time, money, and energy.

A home computer can do four types of jobs for a small business: sorting, searching, coordinating, analyzing, or preparing information; receiving and "capturing" information; printing out reports and needed business documents; and interacting for special uses, such as retrieving information to check a customer's file after a complaint. A home computer—an all-purpose machine—can do any of these tasks, if not at the same time, then within a few seconds of each other.

The two main benefits that a home computer confers even on someone with a weekend, at-home business involve time savings and, more importantly, control. For example, say you have a small business that generates about 50 checks each month and a lot of petty cash vouchers. In the past, you may have balanced your own books once a month, maybe only once a quarter. How long did it take, if you figured out the petty cash vouchers, cash expense receipts, deposits, and so forth once a month? Four hours? Eight hours? Probably the latter over two or three days. And between reconciliations, how did you know where you stood in your business? You compared daily receipts and checking account balances to current bills. But that picture probably didn't show you in what direction your business was headed.

How long would it take you to complete a thorough financial analysis, including factors such as debt/equity ratios, inventory turnover, days sales outstanding (or average collection period), net profit margin, return on equity, and return on investment?

If you're like most small businesspeople or people with at-home businesses, you've never figured out and analyzed these essential business facts. You may be thinking as you read this, "Only big companies need to do that." Or "I can't do that. I don't have time, I don't know how, and I don't have enough money to pay my accountant to do all of it." Sound familiar? If it does, you have just discovered only a few of the ways a home computer will help your business. With these essential business facts, you can gain, for the first time, the information you need to develop a precise, clear, and accurate picture of your business. *Control* is the word that big companies use to define this helpful procedure.

For the first time, this couple can do a quick, accurate, and effective cost analysis of their home business. The APF Imagination Machine is just one of many home computers that can generate colorful bar graphs to aid a small business. (Courtesy of APF Electronics)

A home computer, with the proper (and widely available) programs, can do all of these functions for you in minutes. Most of the time you spend on it would simply involve entering data, and many people can hire an assistant or teach their children to enter the numbers. The home computer does the rest and will display the results of a complete financial analysis or an instant statement of your company's current financial condition. It all depends on which series of buttons you push.

But there's a catch. In fact, it's more than a catch; it's a difficult, careful process to make sure that you buy the right home computer for your small or at-home business. First, only a "small" small business can buy an inexpensive computer and use it for basic tasks like accounting or payroll for one employee. Many small businesspeople and professionals, such as doctors, lawyers, and accountants, have failed to understand this principle and have purchased home computers without enough power,

memory, or capability to perform the jobs they want to computerize.

To perform adequately, an at-home professional system based on a home computer should have these basic elements:

1. A 16K RAM microcomputer (32K would be even better). One may upgrade or expand a 4K or 8K RAM home computer for a few hundred extra dollars. For example, many small, small businesses simply use an Apple II Plus, a TRS-80 Level II 16K model, or similar machines.
2. A large cathode ray tube (CRT) monitor or video screen. An at-home business usually only needs black and white, but color, such as the quality one gets from the Compucolor II or the Apple, certainly provides more vivid charts and graphs. The screen should have a minimum of 16 to 24 lines by 40- to 64-character columns.
3. A complete typewriterlike keyboard. A basic keyboard with 53 keys usually performs adequately, but a keyboard with four cursor (indicator) keys that move up and down and back and forth across the line, basic command keys (for ease and speed of operation), and an 0–9 number keypad on the right side works even better. These features would mean a minimum of 70–75 keys.
4. At least one good disk drive storage device. For small, small businesses and part-time,

The photo illustrates the essential elements of a good system for small or at-home businesses. The home computer shown here is a Heath Company H-89 intelligent terminal with a built-in floppy disk and an H-14 dot matrix line printer. (Courtesy of Heath Company)

at-home businesses, a cassette tape recorder can work quite adequately if a person doesn't mind the inconvenience of waiting a few minutes for some programs to load or "dump" information. A mini-floppy disk drive should work for most small business-people and professionals quite well.

5. A good quality printer. Many printers that adequately print out invoices, reports, and other documents cost less than $1,000. But if you have a business (such as a law firm) that absolutely requires letter-quality print, you can expect to pay between $2,500 and $3,000 for one that will do the job. The Japanese are said to have developed a printer with good print quality for less than $2,000, but it had not reached the United States by the end of 1980.
6. A complete operating system, controller, and assembler system software. To make best use of a home computer, a business owner needs to increase the speed of its operations, and complete OS software answers that need.

With these six elements in mind, a business owner is advised to follow these rules of thumb to avoid starting off on the wrong foot:

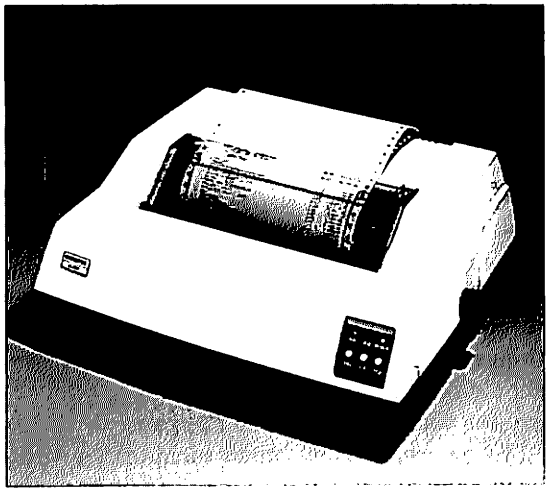
- The key that unlocks the door to home computing success involves buying a home computer that operates easily and understandably. A small business owner should avoid buying one that either does not do enough or does too much for what he wants.
- Remember that every business has unique qualities, most of which derive from the way the owner manages it. Every person puts his personal stamp on his business, and he can insist, to a far greater extent than he realizes, that a home computer and its programming fit his personal style. The idea remains to make sure the computer works to your benefit and not the other way around.
- When picking a printer, avoid converted typewriters or converting your typewriter, unless it has been highly recommended by a reputable store or company. You would make a big mistake to save a few dollars by buying a converted typewriter from a bargain-basement-type operation. You would do better to use an inexpensive dot matrix (for most applications) or a daisy wheel printer (for advanced applications).
- Most important, plan to lower your expectations and raise your estimates of how much time and trouble you will need to buy a good system and get it running to your satisfaction. You can expect the process to take two or three times as long as you'd originally planned and would like. "Bugs" or problems are likely to appear in the hardware and, more importantly, in the software for a reasonable period of time. You can also expect it to take some time for you and your employees to learn how to use the system like an expert. You could compare it to learning to play tennis; at first, it's hard to get the ball over the net, then, it's hard to develop a good serve, and finally, although it's still difficult, you develop a well-rounded game. To accomplish that requires practice and a lot of it. The same holds true when learning how to use a home computer, especially in a small or at-home business.

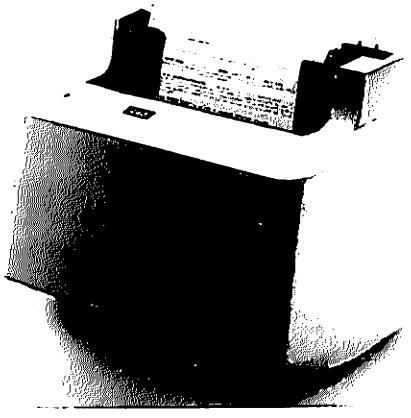
A computer is supposed to be a magical machine that will solve all your problems at the touch of a button after it scares you to death. Well, it ain't.

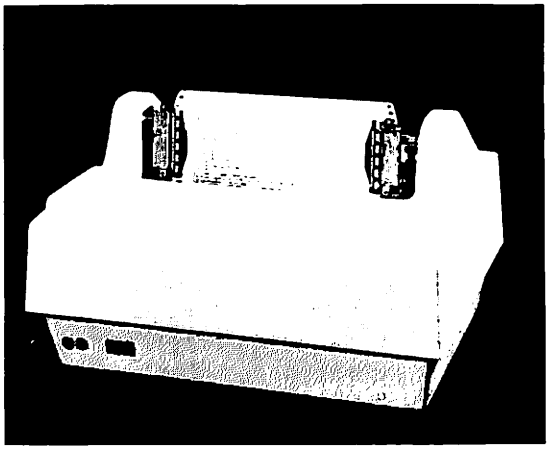
A Thorough Business Plan

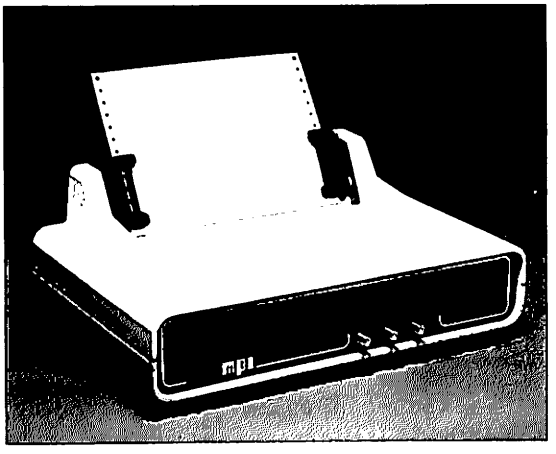
You can easily understand that to achieve the goals of saving time and money and gaining more control, you should complete a thorough advance plan before you buy. If you draw up a detailed analysis of how your business functions, you will be pleased with the results in many ways. First, convince yourself that this purchase—whether $1,000 or $5,000—will result from a serious, thought-provoking process.

Many small-business people, myself included, have found that by forcing themselves to look at









These four represent relatively inexpensive dot matrix impact printers, which are commonly used in small or at-home business applications. They range in price from about $600 to $1,000. They do not produce letter-quality print, but do print adequately for reports, forms, invoices, bills, tax returns, accountant's worksheets, and so on.

A. The Microtek MT-80P dot matrix line printer with up to 120 columns and a print speed of 125 characters per second. (Courtesy of Microtek)

B. The Paper Tiger—Integral Data Systems 440 dot matrix line printer with up to 132 columns, a print speed of up to 195 characters per second, a built-in microprocessor control, and up to 42 lines per minute printed. (Courtesy of Integral Data Systems, Inc.)

C. The Vitek Model 801 dot matrix impact printer with up to 80 columns and a print speed of up to 132 characters per second. (Courtesy of Vitek)

D. The MPI Model 88T dot matrix impact printer with a maximum print speed of 100 characters per second and 80 horizontal columns. It can accept roll paper, cut sheet paper, or fan-fold paper. (Courtesy of Micro Peripherals, Inc.)

their business, function by function, step by step, and objective by objective, they learn for the first time how their business really operates. This in itself has changed many people's thinking and saved them great chunks of time and large sums of money.

For example, a part-time tax preparer in Brooklyn, New York, bought a 16K PET and wrote his own income tax programs for it—after having a home computer for less than a year. He used to work eight hours a day at his accountant's job and then work at home until midnight or 1:00 A.M. filling out returns. Today, with only an extra cassette tape recorder, but no other fancy peripherals, his PET does everything he used to do by hand. Whereas he used to complete five to ten returns a night, the PET is so fast and reliable that he could now easily do 100 Form 1040A tax returns each night. But only after he diligently worked out the best possible home computer for his needs and price range, and spent months perfecting his programs, could he realize these enormous benefits.

To follow the same path, take these planning steps before you buy a home computer to use in a small business:

- In a well-organized, written manner, define exactly what you want your computer to do. Establish exact objectives for your home computer, such as "In one year, I want my entire credit and collections system, including accounts receivable, days sales outstanding, lines of credit, and so on, to be on my system."
- Realistically determine what a home computer can do. For example, you can't expect a 8K RAM PET to keep track of an inventory of 5,000 products.
- Take a hard look at your "inputs," or written forms, reports, bookkeeping methods, and accounting systems. Decide which functions can easily be computerized and start your system out with them. Then define these functions and show what you want to see on the video display, on printouts, and stored in a mass storage device. Repeat the process for "outputs"—checks for payroll and bills, orders, customer billing, and so on.

With this plan in hand, you are ready to begin looking at home computers, peripherals, and system software. Above all, remember that you should look before you leap. Before you begin investigating hardware, you should bear a few things in mind; first, and most important, you should determine an adequate amount of memory for your home computer.

To determine how much memory you may need, look at an average record, such as a general ledger or accounting record—an average record will require 40–60 bytes. Then determine the total numer of records you'll have—the number of items in your inventory and the total or average weekly number of cutomers are two good measurements for a retail store. Say you have 75 items of inventory, which require 60 bytes of memory for each item; that's a total of 4,500 bytes (or more than 4K). In addition, you have 25 customers or clients, which raises the total to 112,500 bytes. When you add a reasonable 20 percent margin, the total is increased to a needed RAM mass storage of more than 135,000 bytes or 135K. Storing that amount of information would usually require an eight-inch floppy disk drive, or a system that puts the program on two mini-floppy disks and lets you split the customers onto two disks, say, alphabetically from A to M and N to Z, or a similar division.

Or perhaps your business requires extensive correspondence, reports, or proposals. In most computers, one character—letter or number—equals one byte, and a written or typed page—with 26 double-spaced lines—holds an average of 250 words or 1,560 characters per page. Taking into account normal disk operating systems (which take up to at least the first six tracks of any disk), an average mini-floppy disk can hold about 30 pages of text. If one is writing a book,

he can look forward to storing the text on eight or nine different disks, duplicating the operating system on each disk, if he needs to recall any of the text out of the disk memory.

Look Out for Hidden Costs

With these ideas in mind, you can begin your investigation and evaluation of each home computer. Remember to include the hidden costs. An adequate home computer may sell for $1,000, and you may think that you're going to solve your problems for that price. But you have to add how much you're willing to spend for computer assistance for everything from the significant cost of complete software to the costs of paper, supplies, service, maintenance contracts, and so on. Although the rule may not hold true for small or at-home businesses, a good rule of thumb is that home computer software and services may equal the cost of the hardware. If you want or need customized software, the cost will far exceed the hardware price.

As you begin looking into different home computers, you'll probably visit computer stores or a department store that sells home computers. Anyone who plans to use a home computer in business is strongly advised to buy from a retail computer store that has knowledgeable employees who not only sell systems, but also know programming and service, maintain machines, offer technical and operating assistance, train you and your employees, and keep on top of developments that can help you.

At the same time or before you visit computer stores, read about the systems in which you have an interest in books and magazines. One helpful tip is to buy one or two specialty magazines when you begin thinking about buying a home computer and send in the magazine's Reader Reply Card. On a reply card, you circle the numbers of the products or items you want more information about, and within a few weeks, the manufacturers will cram your mail box with information. While you do this research and reading, you could be drafting your five-year business function plans, and begin to bring an orderly process to a successful conclusion.

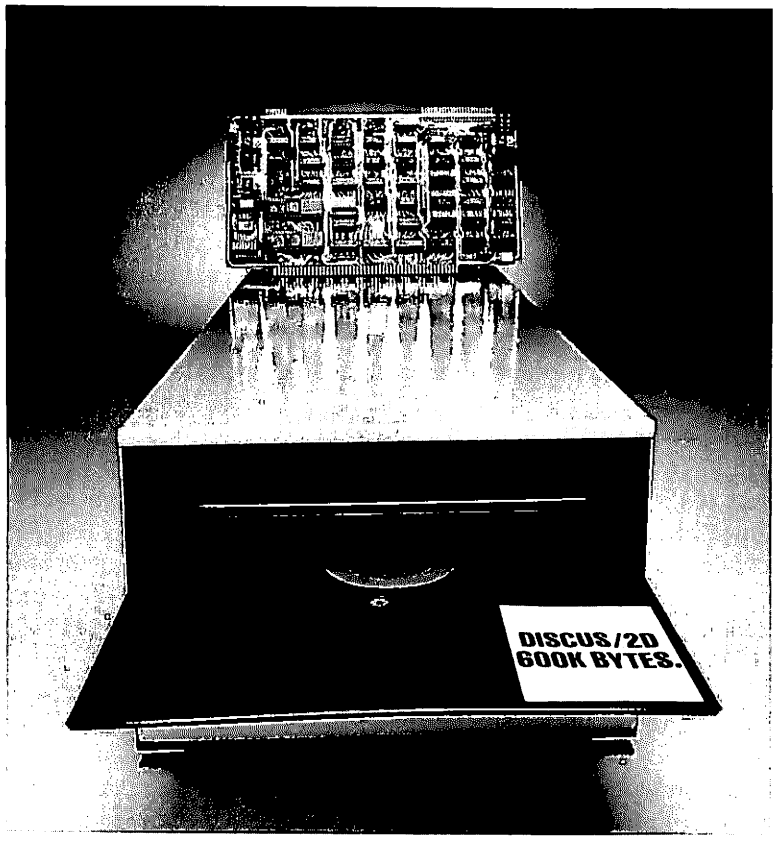
During your visits to stores—pick at least two or three in your area—ask probing questions about each home computer's reliability and make sure the computer has excellent documentation, including well-written, understandable manuals for the computer, all the peripherals, software languages, applications programs, and the computer and disk operating systems. Be sure to find out how far you can expand the computer's capabilities—how large its memory can grow, how many and what kind of peripherals can be added, and how new applications and software can be added most easily. Ask the dealer how much help he gives in setting up and debugging the system after you take it home. Make sure the dealer offers a good maintenance plan or service contract.

An important point concerns what happens to your computer if it malfunctions. Few retail stores make house calls, but other than having to bring the computer to the store, you should know whether the dealer can fix it in the store or must ship it back to the factory. If the dealer has to ship it out or take more than a few days for repairs, determine whether he'll loan or rent you a machine for the duration.

Then be sure that the dealer gives you three to five names of other customers and call them to ask if they were pleased with his service. After you leave the store, check with other people who have the same home computer you plan to buy and ask their honest opinion of the computer, the manufacturer, and the dealer from whom they bought it. User's groups and computer clubs are especially helpful with this information.

Worth Its Weight in Gold

Even after all of this, a prospective buyer may still only be halfway home. You could have a Cadillac of the home computer market—an ex-



Thinker Toys, Inc.'s Discus double density disk drive holds 600,000 bytes of memory storage or information, an example of a powerful system for a small business with a large inventory or large numbers of accounts. (Courtesy of Thinker Toys, Inc.)

cellent machine, the best peripherals and a perfect functional plan. But if a Cadillac tries to run on either the wrong octane gasoline or watered-down gasoline, its engine soon sputters or stops working. In short, good software makes a good home computer system for a small business.

The market for small business programs has exploded since 1979, bringing in dozens of new companies and hundreds of new programs for different systems. Most of them sell what are known as "packages," a collection of programs that carry out all the operations used in common business applications, such as general ledger, accounts receivable, inventory control, word processing, file (or data base) management, production scheduling, and so forth. They normally include all the required operating system programs, BASIC language instructions, and applications software.

The latter three make up three of the four kinds of software that every computer must have. The fourth, called "firmware" or the "monitor," provides a short program in ROM that gets your computer up and running and enables the computer to "communicate"—receive input and send output—with its operating system. Some home computers have versatile operating systems locked into their ROM memory, including the TI 99/4. As we've discussed, an OS or operating system manages the flow of data among different programs and parts of the microcomputer. Applications software has the most interest for small-business people because it consists of the repertoire of programs required to do the specific jobs they want done.

Packaged versus Do-It-Yourself

Few small businesses or people who have at-home businesses can afford custom software, the best way to get applications software for their new home computers. A professional programmer writes programs for a small business to its exact specifications to provide custom software. But at $20 an hour and up, the costs of programmers put too much strain on most small business budgets to be a realistic choice.

That leaves two choices: packaged or do-it-yourself programming. Packaged software can be very cost effective if a buyer gets the right programs. Their prices range form less than $20 for simple programs to thousands of dollars for very complicated and detailed programs. Most fall toward the lower end—$50 to $100, a reasonable price.

Packaged programs have one obvious and serious drawback: they will not perfectly fit your business needs. Packages offer general solutions to common problems, but, as you know, your business has its own special twists.

A buyer is not necessarily hamstrung by the package's general nature. He can determine whether the package can be adjusted to match his requirements, or he can compromise his own desires and match his plans to a good package. No one, however, is advised to buy software that doesn't mostly match his plans. Too many small-business people buy a home computer to use both at home and in their business because their children like its features rather than because it meets their business needs. Most home computers that fit a business can easily please the children, too.

A buyer should continue to follow through on his plan when he buys software. He should "test drive" the software at the dealer's store just as he test drove the hardware. If you plan to buy both together, make sure you try out the business software on the hardware before you make a final decision.

A buyer should investigate the software house in as much detail—if not more—as he did the hardware manufacturer. And he should plan to take as much time as he needs to properly judge the reliability, compatibility, and capability of the software packages before making a final decision. If he considers each of the following nine factors, he can make a good software purchase.

FACTORS BY WHICH TO JUDGE SOFTWARE

1. Quality of documentation
2. Ability to interface (or work compatibly) with other packages
3. Installation requirements
4. Ability to run on different home computers
5. Ability to alter or modify the package
6. Ability to recover from computer malfunctions
7. Ability to doublecheck entries
8. Safety and security of software
9. Efficiency and speed of operation

Do-It-Yourself Software

Any small business owner can certainly prepare his or her own systems programs. (Programming is discussed more fully in the next chapter.) The new owner will begin by studying a high-level language—probably BASIC, though it could be FORTRAN, PASCAL, COBOL, APL, or several other common languages. Most people stick to BASIC, for two reasons: the least expensive and most powerful home computers at present can be programmed only in BASIC or PASCAL; and BASIC has a number of useful variations. Anyone can find a BASIC language variation to fit his or her programming needs. And if a buyer knows one kind of BASIC, he won't find it too hard to learn more variations. (The variations have been compared to regional dialects of the English language, with one BASIC variation being like a Midwestern twang, another like a Southern drawl, and so forth.)

Once you start learning programming and discover how easy and sensible it can be, you

are advised to study how to make your programs as interactive as possible. Most home computer programs, especially those for games and simulations, are very interactive, and a businessperson will get the most out of his or her programs because anyone, even someone with no knowledge of home computers, can learn how to use the programs with a few hours' training. Interactive programs usually prompt users with yes and no questions and guide them through lists of "menus" of information. The more interactive the program, the less problem it will be to achieve your main goal, saving time and money, because it takes less time to learn and use. The computer thinks for a user, and often, a user simply types in one-word answers, fills in blanks or answers multiple choice questions.

Software Houses

The following is a list of some of the most reputable software houses. The list is not complete, and other companies are invited to send their names to the publisher for future listings.

Aladdin Automation, Inc.
3420 Kenyon Street
San Diego, CA 92110

Administrative Systems, Inc.
1642 South Parker Road,
Suite 3000
Denver, CO 80231

The Boston Systems Office, Inc.
400 Totten Pond Road
Waltham, MA 02154

Computer Systems Design
Box 735
Yakima, WA 98907

Cybernetics, Inc.
8041 Herman Avenue,
Suite 208
Huntington Beach, CA 92647

Cybermate
R.D. #3, Box 192A
Nazareth, PA 18064

Digital Research, Inc.
Box 579
Pacific Grove, CA 93950

Graham-Dorian Software Systems
211 North Broadway
Wichita, KS 67202

GRT Corporation
Custom Products Division
1286 North Lawrence Station
Road
Sunnyvale, CA 94086

Lifeboat Associates
2248 Broadway, Suite 34
New York, NY 10024

Mad Hatter Software
900 Salem Road
Dracut, MA 01826

MicroPro International Corp.
1299 Fourth Street
San Rafael, CA 94901

Microsoft
10800 Northeast Eighth,
Suite 819
Bellevue, WA 98004

Microsource
1425 West 12th Place
Tempe, AZ 85281

Microledger
2171 Sharon Road
Menlo Park, CA 94025

Micros Unlimited
Box 486
Stanhope, NJ 07874

Micropolis Corporation
7959 Deering Avenue
Canoga Park, CA 91304

Microwave Systems Corp.
2035 East Ovid Avenue
Des Moines, IA 50317

Osborne Associates
630 Bancroft Way
Berkeley, CA 94710

Rothenberg Information
Systems
260 Sheridan Avenue
Palo Alto, CA 94306

Michael Shrayer Software, Inc.
1253 Vista Superba Drive
Glendale, CA 91205

Software-80
18228 Cabrillo Court
Fountain Valley, CA 92708

Scientific Research, Inc.
Box 490099-B
Key Biscayne, FL 33149

Technical Systems Consultants,
Inc.
Box 2574
West Lafayette, IN 47906

Taranto Associates
Box 6073
San Rafael, CA 94903

12. The Next Step Beyond: An Introduction to Home Computer Programming

ALTHOUGH HOME COMPUTERS have rapidly become push-button machines, much like home stereo systems or videocassette recorders, they have an important difference—you can control a home computer almost as perfectly as you can control a car when you're behind the wheel. Although you can control a programmable stereo outfit, a programmable videocassette recorder, or a programmable microwave oven by pushing a number of buttons, "programmable" in these home appliances means that you simply set the time of day and date on which you want it to operate on the channel (or temperature) you select. The effects are limited because each appliance's capabilities are dedicated to one purpose. Home computers, on the other hand, work as general-purpose machines and can accomplish a wide range of tasks through programs.

Thousands of programs have been written—and continue to be written—for practically every kind of home computer. But even these thousands don't now—and may never—cover everything you want a home computer to do for you in the way you want it done. Rather than giving up and ignoring computers, you can learn to program your home computer yourself. Almost all home computer manufacturers have recognized that until the software houses completely saturate the market, their customers may want to program their machines themselves; thus, they have made sure their machines can be programmed in some form of BASIC language.

You may think that you don't want to learn programming. If so, you don't have to learn it; you can certainly use a home computer for dozens of applications with commercial software and software packages. You can also spend your time searching through back issues of computer magazines to find printed programs that fit your needs. Then you need only sit at your computer and laboriously type in exactly what the program states—making sure that it was written for exactly the same machine configuration that you have. If it doesn't match, you'll still have to know some programming to make the minor changes the printed program requires to work on your different machine. In the long run, you'll find it simpler to have written the program yourself. A knowledge of programming will also enable you to get more use out of your home computer and save more money.

Many variations of BASIC language exist, and each one has certain peculiarities. A knowledge of the most common one, called Minimal BASIC, will give you more than enough to work with any home computer now on the market.

When people reach this point in buying a home computer, they often begin to despair. Books and magazines and stories they've heard from friends have excited them with prospects of a marvelous electronic helpmate. But when some writer starts telling them they have to learn to be computer programmers, they see visions of a year's tuition and boring night classes at some fancy computer training school. Nothing could be further from the truth. Many books have been published in the past three

years that will teach you the principles of BASIC at home with about eight or ten hours of self-teaching.

Learning to communicate with a home computer may be easier than communicating with your children. (At least a home computer won't talk back, unless you tell it to.) And computer languages, unlike human languages, have no nuances or inflections; they all communicate with logical and precise grammar and syntax. If you give a computer an unclear or incorrect instruction, it immediately tells you so in a message such as "SN ERROR," for syntax error. A computer won't shrug its shoulders or tell you it understands perfectly when in fact it's missed the point.

Computers need languages to read, understand, and execute programs—or lists or sets of detailed instructions that tell what and how to perform your commands. A *machine language* instructs the home computer in its own internal language, lists of digital codes that match the bit patterns etched into the computer's integrated circuits. BASIC, on the other hand, which closely resembles English words, is a *high-level language* and cannot be used to address the computer directly. If you talk to your computer in BASIC and it only understands machine language, you can't communicate—it would be like trying to speak English to someone who only speaks Urdu or Ashanti. Each home computer, therefore, must have an *interpreter* that translates BASIC into machine language and vice versa.

BASIC interpreters differ widely, and simplified ones such as a Tiny BASIC interpreter can only accept less complicated instructions, not more complex ones such as BASIC Plus and Extended BASIC. The latter two and others borrow certain features from more advanced high-level languages such as APL (A Programming Language) and PASCAL (an increasingly popular language for use with the Apple II and III), such as abbreviated commands, which a computer understands as if they were full commands.

The power and capability of your computer's interpreter can be determined by the amount of memory it requires. Practically every commercial program indicates a notation like "8K BASIC" or "16K BASIC" or "APPLESOFT 16K BASIC." Those notations tell you how much memory the interpreter itself fills when it is loaded into a computer. Thus, if you have an 8K RAM and the BASIC interpreter is an 8K BASIC, you would have to add more RAM memory in order to write any programs. If you have a 16K RAM and require an 8K interpreter, then you have a maximum of 8K RAM with which to write your programs.

Each home computer requires a specific BASIC variation and a specific interpreter, which usually apply to that home computer or to one with exactly the same microprocessor, and perfectly compatible peripherals, interfaces, and software. In many cases, you can buy interfaces that translate different interpreters and allow one machine to understand another.

Fortunately, more and more home computers do not use up the available RAM memory with a BASIC interpreter. Their interpreters are *resident* or built into the computer's ROM memory. That means the manufacturer has etched the interpreter into the microprocessor circuitry along with the operating system and the primary BASIC language. Texas Instruments' 99/4 and the Apple II and III are two that have resident interpreters. However, as you can see in the Appendix, many manufacturers and software houses provide interpreter programs for each machine; quickly loading an interpreter with a cassette recorder or a disk drive is simple and easy.

The Roots of BASIC

BASIC (Beginners' All-Purpose Symbolic Instruction Code) was first written more than 20 years ago at Dartmouth College by John Kemeny and Thomas Kurtz. They were the first to see the need for a computer language that could be easily learned by beginners and students

with no knowledge or background in computers. Before BASIC, the only computer languages were for advanced scientific, mathematical, and business uses, such as FORTRAN (Formula Translating System) and COBOL (Common Business Oriented Language). Since Kemeny and Kurtz, experts have realized how flexible the language can be and have developed all the variations on the market now. Common variations used in many home computers include Tiny BASIC and a variation, Palo Alto Tiny BASIC; Minimal BASIC, an industry standard; Basic BASIC; Extended BASIC; Texas Instruments' BASIC (for use with its 99/4); and the highest level, BASIC Plus. Variations of Disk BASIC include disk drive commands with the regular language.

Other variations are Integer BASIC and Floating-Point BASIC. These two indicate the types of mathematic operations a BASIC can perform. The former can handle only whole numbers (1+2, 7−5, 247+379, and so on), while the latter can manipulate numbers with decimal points (2.333, −3.456, 17.589, and so on). Other variations can perform more scientific and mathematic functions, such as scientific, algebraic, geometric, or trigonometric notations. Each type of BASIC program and interpreter will clearly indicate whether it handles integer or floating-point mathematics. If you don't immediately find out what BASIC variations your home computer has, ask the dealer and discuss its mathematic capabilities with him. You need to know this information for an application as simple as balancing a checkbook. If your machine only has simplified Integer BASIC, you won't be able to balance your bank account perfectly; you'll only be able to use whole, round numbers, and that's not enough.

Types of BASIC Operations

Each BASIC language has five kinds of operations: arithmetic; input/output; control; "library" functions; and extensions. The first is obvious, but with BASIC, special symbols are used to indicate multiplication, division, and exponentiation—or raising a number to a power (such as 2^2—2 squared—or 3^3—3 cubed). Input/output includes special commands and statements that tell a home computer to accept or transmit information. Control includes specific commands that tell a computer to carry out or execute your instructions within the program. The library functions have a special name because they perform special advanced mathematics instructions that reside in the BASIC interpreter. The extensions concern special instructions that have been added to the BASIC with a specific program for extraordinary application.

Each of these kinds of operations can work in two *modes:* direct mode and indirect mode. The direct mode occurs when you get an immediate answer from the computer after you've typed a line on the keyboard. For example, if you type

PRINT HELLO

and then press the carriage return or the RETURN key, the computer screen should show

HELLO.

If you type

PRINT 2 + 5,

the computer should show this

2 + 5.

The indirect mode, on the other hand, allows one to write a program and use the elements of a complete computer program.

A Program's Fundamental Elements

Each program contains three basic elements: line numbers, lines, and statements. Line numbers begin each line in a program and give a program a way to understand where to put each successive line. What you enter or write on each line is called a *statement.* For example, the following contains all three basic elements:

10 PRINT "MY DOG HAS FLEAS"

Press RETURN and the computer will display

MY DOG HAS FLEAS

The computer displays any message that follows the word PRINT. To be a correct print

statement, and for the computer to remember the line, the statement must be placed in quotation marks.

A line statement enclosed in quotation marks is also called a *string*. The quotation marks enclose a string, but are not part of a string itself. A string can have numbers, letters, or special characters, including commas, mathematics operators, and so forth.

To make print statements and strings into a complete program requires only one additional step: pressing the Run key. For example, the following steps illustrate a complete computer program:

TYPE IN	PRESS
NEW [Typing in NEW clears the computer]	RETURN
10 PRINT "MULTIPLICATION TABLE FOR 7"	RETURN
20 FOR K=0 TO 9	RETURN
30 PRINT K; "TIMES 7 = "; K*7	RETURN
40 NEXT K	RETURN
50 END	RETURN
RUN	

The RUN command tells the computer to follow the instructions or execute the program, and the computer will display the following:

```
MULTIPLICATION TABLE FOR 7
  0 TIMES 7 = 0
  1 TIMES 7 = 7
  2 TIMES 7 = 14
  3 TIMES 7 = 21
  4 TIMES 7 = 28
  5 TIMES 7 = 35
  6 TIMES 7 = 42
  7 TIMES 7 = 49
  8 TIMES 7 = 56
  9 TIMES 7 = 63
OK
```

The OK that the computer displays at the end signals that the program is completed and that the computer can accept a new program.

TYPICAL BASIC INSTRUCTIONS

NAME	DEFINITION
Statements	
CALL	Calls up computer subroutine
DATA	Computer holds information for READ
DEF	Defines statement function
END	Indicates last statement in a program
FOR . . . NEXT	Establishes and executes a loop
GO TO	Sets up unconditional branch in program
IF . . . THEN	Sets up conditional branch
INPUT	Asks terminal for information or data
LET	Assigns a definition to a variable
PRINT	Types normal strings or numbers
READ	Moves information from DATA into program
RETURN	Brings program back to last subroutine
RUN	Executes the program
STOP	Ends the program
Commands	
BYE	Takes computer out of program
DEL	Deletes from program
LIST	Display entire program
LOAD	Accept a program from memory
NEW	Indicates new program for memory
SAVE	Preserve and store the program in memory

If you want to see a listing of your program after you've pressed RUN, you just type in LIST, and the computer will automatically display the program listing as it's stored in the computer.

RUN and LIST are just two of many commands that BASIC language provides for you to tell the computer what to do. Commands do *not* require PRINT typed before them because PRINT is a command of its own, and double commands would confuse the computer.

Other common commands include SAVE, which stores programs on cassettes, tapes, or floppy disks. To call up a program already stored on a cassette or disk, one uses the LOAD command, and so forth. The following table lists the most common BASIC commands, but some BASIC variations use different words for these commands. Your home computer's operating manual will make clear which words your computer uses.

A frequent variation of the OK display is the word READY. Most home computers allow a user to put a title or headline on each new program with a REMARK instruction. For example, in the multiplication program, instead of the 10 PRINT statement, you could have added to the top of the program

```
10 REMARK *** THIS IS A MULTIPLICATION TABLE
```

And the computer would display

```
THIS IS A MULTIPLICATION TABLE
```

Fundamental Arithmetic Operations

A home computer does not include the normal symbols for division or multiplication because a typewriter keyboard does not contain the former symbol, and the "x" or "X" which usually means multiplication means something different in computer language. The symbols for multiplication and division are "*" and "/," respectively. A home computer also has an exponentiation symbol instead of the usual 2^2 or 3^3; it is an arrow pointing upward ↑.

With the five basic arithmetic symbols or *operators,* a home computer will work like a calculator, and you can program into it basic arithmetic operations. For example:

```
REMARK *** THIS IS AN ADDITION PROBLEM
10 PRINT "A = 2"
20 PRINT "B = 3"
30 PRINT "C = A + B"
40 PRINT C
50 END
RUN
```

And the computer will display

```
THIS IS AN ADDITION PROBLEM
A = 2
B = 3
C = 5
OK
```

A simpler version would have left out the print statements and quotation marks (the information would then not have been retained in memory) and looked like this:

```
10 A = 2
20 B = 3
30 C = A + B
40 PRINT C
50 END
RUN
```

And the computer would have displayed

```
5
```

You can use home computers as a five-function calculator (or more, if the keyboard and the BASIC interpreter provide the mathematical functions) without knowing any programming at all.

Other Operating Statements

INPUT/OUTPUT

PRINT is called an input/output statement. Three other such statements are READ, DATA, and INPUT. The READ statement, which works together with DATA, instructs the computer to accept information and store it in memory locations specified by READ state-

ment labels. The computer obeys a DATA statement and displays the information that a user stored in the same order in which it was entered by the READ statement. For example:

```
10 READ A, B, C
20 DATA 1, 2, 3
```

The INPUT statement can be used as an alternative to the READ/DATA statements and speeds up the operation. For example:

```
10 INPUT A, B, C
20 S = A + B + C
30 END
```

The computer understands that the INPUT statement implies that the user will add information or data later. With a prompt symbol, a user could then type in

```
(prompt) 1, 2, 3
```

and the computer would understand that the user meant A = 1, B = 2, and C = 3.

CONTROL

The two most important control operations in BASIC are GO TO and IF THEN. A simple example of a GO TO operation follows:

```
10 PRINT "GOOD BY"
20 GO TO 10
END
```

And the computer will begin to print out GOOD BY, GOOD BY, GOOD BY, ad infinitum.

The IF THEN operation establishes a *conditional* statement and moves control from one statement to another. It can be used to establish a loop, end a loop, or end a program, depending upon whether the condition in the IF THEN statement is satisfied.

An example is a set of program statements that commands a computer to display a series of numbers, such as counting from 1 to 100, or counting by twos or threes, or any series of repeated numbers or statements. The operations FOR and NEXT are essential in *loops,* which set up a series of repeated statements.

LIBRARY

Library functions are of less use in beginning home computing, since they consist of higher mathematical functions and include sine, cosine, square roots, tangents, logarithms, and others.

EXTENSIONS

Extensions are often included with even simple BASIC languages to make them a little faster or more versatile. The most popular and important extensions include PEEK and POKE commands, which can look at a specific memory location inside RAM and change its contents. Most of them concern programs in very advanced BASIC or assembly and machine languages.

These statements, commands and operations just begin to explore the BASIC language, much as the alphabet and "See Dick run, see Jane run" would introduce English. But you can see that BASIC is not impossible to learn; in fact, it can be very easy to learn if you work at it with a little time and effort, and determine to think logically. Anyone who understands this book's material can be writing BASIC programs within days.

Other Languages

Once a new computer owner gets interested in programming, he or she will find that some home computers offer more than one kind of language. Apple, for example, offers Integer BASIC and Applesoft BASIC, while Texas Instruments has TI BASIC and Extended BASIC. Some have three or four different language capabilities.

Only one software house has written most of these BASIC variations—Microsoft, Inc. They have prepared BASIC languages for PET, TRS-80, Compucolor, and Apple, to name a few. For several years, they have had a standard Microsoft BASIC, and if a user learns that version, he'll be better prepared for any BASIC system that a new computer might have.

Sources of Help

The easiest way for a beginner to learn BASIC is simply to buy a book and start studying. Each home computer with a BASIC programming capability provides a programming manual either free or for a small additional charge. With the computer, the manual, and an instructional book, you have the three best tools available. However, you don't have to have a computer to learn BASIC. Many books teach you BASIC and show you how to write programs on paper before you buy a computer.

Many computer magazines publish a series of instructional articles for different BASIC versions, and they can assist you with programming tips if you're studying from books. BASIC courses are regularly offered through local schools and colleges, and some retail stores either offer or know about BASIC beginner's courses. Any beginner can probably find someone in a local club or user's group who will help him learn BASIC on a part-time basis.

One somewhat more expensive way involves buying an evaluation kit such as the Texas Instruments University Microprocessor Course. An evaluation kit puts a microcomputer and a keyboard in a package with texts and manuals and not only teaches BASIC, but the complete operation of microcomputers, including machine languages. These evaluation kits undoubtedly provide a convenient method of learning everything there is to know about microprocessors and computer languages.

Regardless of how you do it, however, learning BASIC will open up the secrets locked inside your home computer and make you their master.

13. Help for the Handicapped

SHIRLEY, A STUDENT at a southern California college, cannot speak clearly or control her muscle movements. She has cerebral palsy, and for her to attend college or even communicate adequately with doctors or family would have been excruciatingly difficult just a few years ago.

But thanks to a microcomputer and a CRT monitor attached to her wheelchair, Shirley can easily communicate with her teachers, classmates, and family. She can't use her hands to type messages on a keyboard, but the microcomputer—one of the same ones that run home computers—works off the only muscle she can control consistently, her right leg. Her right knee can touch a switch that prints messages out on the CRT display. The computer system, made by Computers for the Physically Handicapped, contains a 1,200-word vocabulary with which she can "speak," and she can spell out any other words she needs.

The system, called TIM, after its inventor, Tim Scully, can be customized for practically anyone who cannot read or write because of a birth defect, injury, or stroke. For example, it helps a writer who can only use one hand to produce camera-ready copy for his publisher, and a young boy to communicate through a switch attached to his right eyebrow.

TIM is only one of dozens of new technological triumphs that have opened up new worlds for the handicapped. They all get their remarkable power from microcomputer electronics or home computers such as the Apple II. In short, as much as Braille has meant to the blind, lip-reading to the deaf, and sign language to the mute, home computers—and devices using home computer "brains"—will overshadow those developments hundreds of times over.

To date, the development of home computer-based aids for the handicapped has lagged for the same reasons that many other recent developments have: too few people know about them; the market remains too small to make mass production economical; and third-party insurers and government rehabilitation agencies do not yet give financial assistance or subsidies for these systems. Furthermore, the price, though comparatively little for a device that enables a speechless person to "speak" for the first time, remains out of the reach of most average families.

Yet dozens of hospital, government, and private researchers are working diligently to overcome these social and financial handicaps so that these new computerized products may soon reach the tens of thousands of people who need them. The products range from a commercial talking calculator and a commercial talking chess computer, called Voice Chess Challenger, by Fidelity Electronics, to sophisticated talking wheelchairs made at Stanford University Children's Hospital. In fact, dozens of new electronic aids have been introduced during the past two years.

They all demonstrate the one central fact that has enormous meaning for the future: the handicapped—the blind, the deaf, the crippled, the retarded, the disabled—now have the chance to be full human beings again. Society has long treated handicapped people as objects of pity or as outcasts. We shy away from vivid reminders

of our own limits and try to block out or ignore people who remind us that tragedies often happen, leaving helpless people in their wake. The home computer and its brothers can now break down these barriers, removing the stigmas and making the handicapped person with even a little ability to think or move able to function almost as well as anyone else.

In the future, scientists may restore sight with electronic eyes, hearing with an electronic aid, and arms and legs with computerized prosthetic limbs. But, experts agree, visions of "the Bionic Man" will not come true. They put their efforts, they insist, into restoring people, not making Bionic Men.

Lack of Compatibility

The lack of compatibility among computers plagues the home computer field. It plagues the development of aids for the handicapped even more. Without great technical difficulty and expense, a talking calculator cannot be hooked up to a talking wheelchair, and a portable electronic printer cannot be hooked up to a Handi-Voice, which speaks words, phrases, sentences, and letters.

Each product is dedicated with only one kind of microprocessor or microcomputer to only one specific aid. Unlike most home computers, however, few, if any, interfaces exist to connect these devices, and no one follows the same standards as anyone else.

But, says Arlene Kraat, Speech Pathology Supervisor at Goldwater Memorial Hospital in New York City, the next generation of aids for the handicapped will be modular, with printers, talking calculators, environmental controls, communicators, and reading machines coming out of the same electronic family. Ms. Kraat and experts in rehabilitation engineering are demanding that all these features be included in the same machine as soon as possible.

As it is, each handicapped person has to spend his or her time—and a rehabilitation therapist's limited time—learning to use each new device as it is introduced. And each new device must be subjected to rigorous hospital and government tests before any national association for a group of handicapped persons will certify its usefulness. Introducing, certifying, learning, and, perhaps, redesigning or modifying new devices piecemeal takes months, and more often years, before they reach the hands of those who desperately need and want it.

Telesensory Systems, Inc., probably the largest maker of commercial aids for the blind with its hand-held Speech-Plus talking calculator, Optacon portable reading machine, and Versa-Braille cassette-based Braille reader, has laid the groundwork for the first modular system. Called the TSI Voice Communication Project (VCP), it incorporates three configurations: a free-standing Optacon, an Optacon with a synthetic voice accessory that speaks when a blind reader scans print by hand, and an automated voice reading system that automatically scans print with the synthetic voice output.

The Optacon enables a blind person to read almost anything, but it works slowly and requires a lot of skill and training. The voice accessory, on the other hand, introduced in 1980, enables a user to read up to 200 words a minute (seeing people hear about 100–150 words a minute; blind people hear much better) and is much easier to use. The automated voice reading system, planned for 1981, adds an automatic tracking mechanism, designed to make it easy for blind people to read novels or skim complicated materials. The complete system allows any blind person to "read" any kind of material, from novels to academic abstracts, at will.

In the VCP, with a modular microcomputer, separate modules perform optical character recognition, text-to-speech conversion, automatic scanning, and controls. The microcomputer controller supervises each part of the system and breaks down text so that abbreviations, dates, times, and dollar amounts are pronounced intelligibly.

Perhaps more important in the long run, the modular system can be upgraded as better

hardware is developed, and the controller and the text-to-speech modules can be combined with a simple computer terminal to provide a talking terminal for blind users. At first, blind computer programmers will find the talking terminals most helpful, but as the terminals are improved, any handicapped person may benefit from similar uses.

The basis of the VCP is *speech synthesis.* TSI has programmed into the microcomputer's ROM an electronic simulation of the human voice. When the ROM receives data signals from the OCR (optical character recognition) module, which basically scans the printed word and converts the letters into digital signals, it, in turn, sends a signal to the microcomputer's controller. The controller fetches the word, determines its speech characteristics (called phonemes), and changes the digital signal into a clearly understood, though metallic, voice.

The TSI Speech Plus® talking calculator works on similar, though simpler, principles. It has a complete microcomputer stored on a single chip, which receives entries from the calculator-style keyboard and sends signals to the speech synthesizer chips: a microcontroller and a ROM chip. The ROM holds information that rebuilds the speech patterns, and the controller reads needed data from the ROM, shapes it into a speech pattern, and sends the complete spoken word to a speaker.

When the Speech Plus was first developed, as one of the first commercial devices with a microcomputer, it had only a single microprocessor and a 16K ROM chip. But consider the advances that had occurred in just two years: in 1978, Texas Instruments produced a speech synthesis chip with 128K ROM for its Speak 'N Spell toy. At that time, the TSI calculator contained only a 1K RAM chip; today, 64K RAM chips—and larger ones are soon to come—are commercial products. All of this power can be translated into aids to help the blind. But for some large companies selling 10,000 talking calculators or 6,000 Optacons does not form a large enough market. Blind people can, however, take advantage of inexpensive, commercial educational toys, like Speak 'N Spell or another new TI product, its talking language translator. With the former, a blind child can use the simple keyboard once he's learned the alphabet, and learn to spell up to 350 words with TI's modules.

In the future, the TI 99/4 home computer, which can be taught to speak 1,100 words, can be used in simple ways. Texas Instruments is said to be working behind the scenes with groups that represent handicapped people and without great fanfare, and many devices already include the TI chips.

Six Basic Categories

Beyond reading and speech synthesis aids for the blind, five other categories of computerized and electronic aids for the handicapped exist: printing communicators; talking communicators; refreshable Braille machines; environmental controls; and prosthetic aids. In each area, researchers are using microcomputers and home computer-based systems to make advances no one had thought of a few years ago.

PRINTING COMMUNICATORS

More than half a dozen machines allow people who are unable to speak or move to type out words, phrases, or symbols by pressing a button or a simple switch. Most of them operate in a similar manner. With either a calculator-/or an alphabet-style keyboard, or row-and-column boards, a handicapped person presses buttons and switches and indicates or points a light at a letter, number, or symbol. When an electrical contact is made, the device prints out the indicated letter, number, phrase, or symbol with a tiny printer. The message is printed out on a ¼-inch paper tape.

The Canon Communicator and Atari's VIDCOM II work with calculator-style keyboards, and the Porta-Printer, the ZYGO 100, the TIC (Tufts Interactive Communicator), and the Auto-Com use the row-and-column board di-

vided into squares. Each square represents one or more types or levels of information. Three of these four work for people who must use a muscle-controlled switch or optical pointers attached to their heads or arms. A light starts at the top row of the board and scans down the rows. When it comes to a desired row, the person hits a switch, even if it means just slightly flexing a muscle. The light then scans across the row until it reaches a desired letter. Then the person again hits the switch and the correct letter is typed out. Admittedly, this is laborious, but imagine not being able to communicate in any other way; the handicapped happily take the time to use the devices.

The most advanced printing communicator, the Auto-Com, is a large, flat board with a matrix of squares. Because the Auto-Com is programmable, each square can represent up to seven different kinds of information. A handicapped person uses the device by moving a magnet from square to square to activate letters, numbers, symbols, phrases, sentences, and so on. The device has an LED display and a small printer so that a user can carry on a conversation with a nurse or type out longer messages to send letters home. The device works as rapidly as a person can move his hand from one square to another, increasing his "talking" speed many times.

TALKING COMMUNICATORS

Two micro-aids, one a small device and one attached to a wheelchair, actually allow a speechless person to speak. The Handi-Voice, by HC Electronics, is preprogrammed with 373 words, 26 letters, 45 phonemes or speech sounds, 16 phrases, and 13 morphemes (prefixes and suffixes). It has 128 touch-sensitive keys, with four selections per key, and six functions, including a programmable memory, which allows a user to develop an unlimited vocabulary. Press a key and the Handi-Voice speaks. Press a series of keys, and it speaks complete sentences.

Primarily for cerebral palsy victims, the talking wheelchair was developed by scientists at Stanford University Children's Hospital. Researchers led by Chief Engineer Maurice LeBlanc combined a specialized computer interface with speech synthesis technology developed for the space program, and created the VPSP (Versatile Portable Speech Prosthesis) Talking Wheelchair.

The wheelchair's microcomputer has a Z-80 microcomputer (the same one used by Radio Shack, among others) with 16K RAM, a floppy disk drive, a five-inch video monitor, and a standard speech synthesizer. The computer equipment is mounted behind the wheelchair seat; the video monitor sits on an extension in front of the chair.

The wheelchair has an unlimited vocabulary, and the user, with only one control switch, can pick either words already in the computer's memory or his own words, much like a home computer user may pick from a range of listings on a menu. LeBlanc has said that the wheelchair can also anticipate what someone is trying to say and finish a sentence when he is halfway through it. Its memory "learns": it accumulates information in its registers and calls up often-repeated words when certain combinations of words or phrases are entered repeatedly.

REFRESHABLE BRAILLE

These machines record and store Braille symbols in digital form on audio cassette tape in the same way a home computer sends digital signals for cassette storage. The information can be automatically recalled, making the recorders "refreshable." TSI developed the first such machine, called Versa-Braille, which can be used as a Braille note taker, filing system, or audio recorder and can be connected to an electric typewriter, a word processor, or a computer terminal. An American Foundation for the Blind vice president, Rami Rabby, who is blind, has said, "Whatever can be shown on other equipment—a calculator, an IBM Selectric, or a computer—can now be automatically translated into Braille and vice versa." Another re-

corder is the Elinfa Digicassette Portable Braille Recorder. Both, experts agree, reduce the great bulk of Braille materials and may open hundreds of new jobs to blind and deaf-blind people.

ENVIRONMENTAL CONTROLS

Many electronic aids help the handicapped control their own environment for the first time. They range from simple touch or pressure switches to integrated circuits and microswitches that operate computers with the blink of an eye. The latter use eye positions to direct signals. Denver Research Institute engineers have developed ocular transducers, which detect infrared light reflected from the cornea of the eye. The transducer, which converts the reflection into a coherent digital signal, fits on a pair of eyeglasses and can be mounted to a wheelchair, a video game, or a computer terminal.

At Harvard and MIT, engineers developed EYECOM, which uses the same transducer to send digital signals to a computer when an eye looks for a moment in one of eight directions. At the University of Pennsylvania, a graduate student developed a home computer that works with the electrical signals from eye muscle movements. He used four bioelectrodes, which amplify eye muscle electrical signals through a digital electro-oculogram transducer. It can operate a voice synthesizer, a TV keyboard terminal, or an environmental control unit.

Other similar environmental controls enable the handicapped to turn lights, machines, and televisions off and on, dial telephones, raise and lower electric beds, operate motorized wheelchairs, and do other tasks that many handicapped people have never before been able to do for themselves.

Shirley's Wheelchair Computer

TIM, the system developed by Computers for the Physically Handicapped, can take care of many of these environmental controls. It is primarily used by people who have cerebral palsy (like Shirley, the college student) to communicate with the rest of the world.

The system, which uses one of three home computers—the Polymorphic 8800, the Apple II, or the TRS-80—must be custom made for each client, an advantage for the client but a disadvantage for the company. If a needed switch is not a standard product, Dr. William Lynas, a Swiss professor, must put together a unique switch to match each client's capabilities: if he can move only a finger, then Dr. Lynas must find or build a switch that perfectly fits the muscle in the finger that can be moved and controlled.

Other than the custom switches, however, the system is much like any other home computer. It uses cassette tape memory storage because that withstands bumps and shocks better than disk drives, and its memory contains 8K ROM and 16K of user RAM, not very large by any standard. It has a small CRT monitor and the standard S-100 bus with five slots for peripherals and easy access to repairs. All of these features, as we've seen, can be found on almost all medium-priced home computers; in fact, with the right software, any 8K ROM and 16K RAM home computer—which includes everything from the Level II TRS-80 up—could be used for similar systems. TIM's base price is only $2,200, although custom-made additions may increase the cost as much as $8,000 more.

Shirley uses the computer by hitting the switch with her leg. She chooses from a menu of system choices that constantly appear on the screen, offering letters, words, phrases, or programs for her studies. Reviewing one entire display, however, takes only a few seconds. If the student chooses the alphabet, the letters appear, not in alphabetical order, but in order of most common usage or the next logical progression. The computer stores 1,200 words in a vocabulary memory file, which Shirley can choose any time, and displays up to 200 words on the monitor at one time.

TIM can be connected to remote switches

and a controller that can operate up to 32 different things, including light switches, home appliances, televisions, book-page turners, or anything a person who can not move, or has little control over his movements, may want to control.

For people who cannot speak, the system software can be rewritten for their needs, including rhymes, games, and simple phrases for youngsters or engineering and scientific phrases for handicapped professionals.

TIM and the VPSP Talking Wheelchair are just two examples of what promises to become one of the most important and exciting uses for the home computer.

Helping the Handicapped with Your Home Computer

Although these devices usually must be custom made by expert engineers and programmed by specialists, home computer hobbyists are gradually learning how they can use their computers to help the handicapped with just a little knowledge. One 12-year-old girl in New York wrote a program that turned her TRS-80 into a talking calculator for the blind.

The simple home controllers described in Chapter 14, which turn lights and home appliances on and off, can be used by bedridden patients. For example, a doctor attached sensors to a baby's crib and wrote his own program for an Apple computer. The computer closely monitors any unusual movements in the baby's crib—movements that could cause a baby to choke—and sounds an alarm if any odd movements happen. The same kind of simple home computer system could be used for bedridden patients.

Handicapped people can be taught how to use simple terminals—with either full keyboards or calculator-style keyboards—to relay messages from one room of the house to another, so that nurses or family members do not have to respond to bells or stay with the person all the time. Simple terminals, working like a communicator, can give severely handicapped but still lucid people a way to express themselves when they want to, without losing their thoughts or typing them out on tiny paper tapes.

These few methods just scratch the surface of a home computer's potential to help the handicapped as a communications medium or a controller, or as a computer dedicated to a specific purpose. The whole field of using computers to help the handicapped—in new hardware, but more importantly, with new, easily used, interactive software—still lies wide open to the new computerist.

Networks for the Handicapped

The handicapped, long forced to communicate in only the most limited fashion with doctors, nurses, and family, can now hook up to the information networks and talk to the world. An Electronic Information Exchange System (EIES) project involves young cerebral palsy patients who use regular keyboard terminals to communicate with senior citizens in a home. During the past four years, the patients and the elderly have spent thousands of hours sending messages back and forth, learning, perhaps for the first time, that someone really cares about them. Of course, the children must understand basic English and be able to type in words and sentences; but if an EIES network were inexpensive enough, even handicapped persons, who could use only eye movements to control a system like TIM, could use the network to talk to other people anywhere in the country.

While the EIES network for the handicapped may be a few years away, the Public Broadcasting System is now demonstrating how a Teletext system can benefit the handicapped, especially the deaf. More than 250 PBS stations are broadcasting subtitles and captions for the deaf over part of the vertical blank space in the television signal, the same space that Teletext systems now use. No technical obstacle exists to prevent cable television networks or individual stations from doing similar broadcasts; many

cable stations today broadcast the stock market displays across a few of their open channels on a regular basis. The drawback so far has been too little money to provide subtitles or captions for every program on the air. But more money and resources are being provided for these services now and in the near future.

In Britain, Teletext—through CEEFAX and Oracle—is broadcasting captions for the deaf on a regular basis, which new American and Canadian Teletext systems could easily emulate.

A Serious Obstacle

But a handicapped person's inherent limitations often prevent him or her from using computerized aids more quickly or to full advantage. For example, typing out a two- or three-line message on a printing communicator may take a severely handicapped person more than ten minutes. Although that speed is excruciatingly slow for someone with his or her mental faculties intact, someone who has not talked to anyone for ten years without using guttural noises and gestures usually accepts the slow speed happily.

Slow speeds for communicators or talking devices may be acceptable, but researchers trying to build computerized arms and legs that duplicate normal movements cannot accept reaction times measured in a communicator's thousandths of a second. They must develop devices with reaction times that are practically as rapid as human thought, millionths of a second or faster.

Knee-Jerk Reactions

The Veterans Administration's Prosthesis Biomedical Engineering Center, led by Chief Engineer Carl Mason, has worked for several years trying to perfect a prosthetic knee operated by a microcomputer chip. The artificial knee is based on a common 8080 microcomputer and a simple analog-digital signal converter. It uses electrical signals from leg muscles to control the tiny computer inside the artificial knee.

A leg muscle generates between 50 and 1,500 microvolts with a frequency of 30 to 800 cycles. Inside the artificial knee, stainless steel buttons pick up these signals when a muscle moves, so that the computer can translate them into movement in the artificial limb. Mason wants to develop a computer-based knee that makes ten different movements, including standing up and walking up stairs. At present, an amputee must do many or all of these ten movements stiff-legged. Getting a tiny microcomputer—the same one in the IMSAI and several home computers—to make those movements is very difficult and requires a very fast operation; in fact, an operation too fast for most current microcomputers.

Mason has said that mechanisms that can respond as quickly as leg muscles have been made. The lapse between the time a leg muscle gives a command and a leg movement is about 10 to 30 thousandths of a second. Present microcomputers take twice as long, and they don't exert enough force to move the aritificial knee. A new kind of semiconductor, called CMOS—complementary metallic oxide semiconductor—is five times faster and requires just 1 percent of the power of the current microcomputers. But it will be several years before they can be used to build artificial limbs.

While the VA researchers patiently continue their work, many other researchers are developing artificial eyes—computerized devices that enable a real eye losing its sight to boost the power of the available light, or create sight patterns within a human brain from light waves hitting a microcomputer attached to a pair of glasses.

While the world waits for these miraculous artificial eyes and limbs, however, thousands of handicapped people all over the country are experiencing their own personal miracles every day. In 1977, a New York City teenager was an honor student and a singer in the All-City Choir. Suddenly stricken by a serious illness,

she was confined to a wheelchair, unable to speak or control her arm and leg movements. Yet, using a combination of the microcomputerized aids discussed in this chapter, she'll finish her high school education using just the one movement she can control—her head.

A 40-year-old woman had an attack like a stroke when she gave birth to her daughter more than a dozen years ago. For ten years she lay flat on her back, unable to move or speak. Today, after years of intense training, the woman "talks" rapidly and writes touching letters to her daughter, using computerized aids.

Both women exemplify the many everyday miracles taking place in hospitals and rehabilitation centers all over the country as home computer "brains" and man's brawn combine to give the handicapped more control over their own lives than has ever before been possible. Home computer "brains" and home computer systems are just beginning to unlock the doors of society previously closed to the handicapped. In a few years, helping the handicapped should become one of the most important ways home computers enter a home for the first time.

Manufacturers

The following is a partial list of the manufacturers of electronic aids:

Computers for the Physically Handicapped, Inc.
7602 Talbert Avenue
Huntington Beach, CA 92647

VIDCOM I and II
Atari, Inc.
Professional Products Division
1183 Bordeaux Drive, Suite 32
Box 9027
Sunnyvale, CA 94086

Telesensory Systems, Inc.
3408 Hillview Avenue
Box 10099
Palo Alto, CA 04304

Offers these aids:
Speech-Plus talking calculator
Optacon portable reading system
Versa-Braille, electronic Braille information processor
Canon Communicator
Auto-Com electronic communication aid
The Game Center—eight electronic games for the blind
Spoken Word Output, a talking reading system
Synthesized Speech Systems

Phonic Mirror Hand-Voice
HC Electronics, Inc.
250 Camino Alto
Mill Valley, CA 94941

VPSP Talking Wheelchair
Maurice A. LeBlanc, Chief
Rehabilitation Engineering
Children's Hospital at Stanford
520 Willow Road
Palo Alto, CA 94304

Porta-Printer
Portacom Company
21 Hudson Street
New York, NY 10013

ZYGO Model 100
Everest & Jennings, Inc.
1803 Pontius Avenue
Los Angeles, CA 90025

Tufts Interactive Communicator
Biomedical Engineering Center
Tufts New England Medical Center
185 Harrison Avenue
Internal Box 372
Boston, MA 02111

ELKOMI II (and other communicators)
Prentke-Romich
R.D. 2, Box 191
Shreve, OH 44676

Eye-controlled communication devices are available from the following:

George Rinard or Donald Rugg
Electronics Division
Denver Research Institute
University of Denver
Denver, CO 80210

Michael J. Rosen
Harvard-MIT Rehabilitation Engineering Center
Massachusetts Institute of Technology
Cambridge, MA 02139
(*EYECOM*)

Ira Laefsky
Department of Computer and Information Sciences
268 Moore School D2
University of Pennsylvania
Philadelphia, PA 19174

Associations

If you are interested in getting more information concerning current research in the field of microelectronic aids for the handicapped, contact the following organizations:

American Foundation for the Blind
15 West 16 Street
New York, NY 10014

The International Action Group for Communication Enhancement
Communication Outlook
Artificial Language Laboratory
Computer Sciences Department
Michigan State University
East Lansing, MI 48824

Dr. Gregg Vanderheiden
Trace Center for the Severely Communicatively Handicapped
University of Wisconsin
Madison, WI 53706

Leslie Solomon
Computers for the Handicapped
45–37 194 Street
Flushing, NY 11358

Veterans Administration Prosthetics Center
Technology Applications Division and Bioengineering Research Center
252 Seventh Avenue
New York, NY 10001

Douglas Boone, Orientation Counselor
Nebraska Division of Rehabilitation Services for the Visually Impaired
Lincoln District Office
1047 South Street
Lincoln, NB 68502

Blaine L. Clegg
The Telephone Pioneers of America
195 Broadway
New York, NY 10007

The Pioneers have developed more than 67 devices to aid the handicapped. More than half are electronics-based, and each chapter will give its aids either free of charge or at cost.

Check with national groups such as the March of Dimes and the Easter Seal chapters for more information.

14. Mother's and Father's Little Helper

SAY THE HOME COMPUTER'S NAME and it answers, "Yes?" Tell it, "Patio lights on," and in a flicker, they're on. Tell it, "Computer, kitchen timer," and it counts the minutes—"One minute, two minutes"—until a roast is done.

In turn, the computer automatically performs tedious, time-consuming tasks around the house. With an inexpensive remote control system, it controls the home heat and air conditioning, a garage door, security alarms, dishwasher, and outside lights. It also talks to you, waking you up in the morning at a prearranged time with a cheery, "Good morning! Time to get up!" while it turns on the coffeepot and a radio, and then tells you what the day's temperature, barometric pressure, and weather forecast are.

It also occasionally calls you "Mom" or "Dad," as the case may be; tells your children that it "loves them"; and calls the dog's name just to be playful. If you think this is fanciful or fantastic, or if you know it's possible but think it's too expensive, think again.

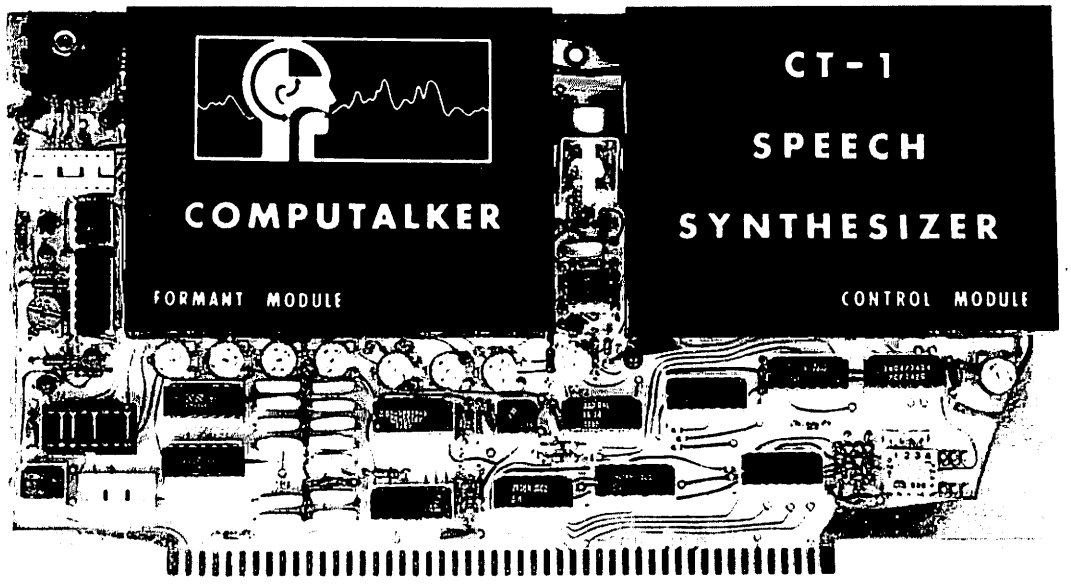
A home computer that does all these things and much more already exists. A science magazine editor has combined an IMSAI 8080 microcomputer with a voice recognition module, a speech synthesis module, a small Pertec (MITS) 680b home computer, and an inexpensive home controller to produce Breslin, one of the most complete and comparatively inexpensive home computer control systems ever made. The significance of what the editor has done lies in his clever combinations: he didn't invent anything new, he didn't take a course in advanced microcomputing techniques (although he was quite good with electronic gadgets), and he didn't have to rob a bank to pay for it. His system does everything with products commercially available at reasonable prices. He did, however, write his own program—more than 52K bytes long—to operate it.

Breslin does everything around the house, acts as a normal home computer for home finances and game playing, connects to a home information utility, and contains the editor's personal data bank. Breslin can follow one of four schedules of things to do, each of which relates to the day of the week, a holiday, and whether anyone is home.

On a video monitor, the home control computer lists 18 different daily functions, the device it controls, each one's "on-time" and "off-time," and current status as well as the current date and time of day.

On the same display, Breslin will also list additional information, including its daily schedule, emergency phone numbers, inside and outside temperature, its talking intervals (every 30 minutes unless someone talks to it or an emergency occurs), and any messages that the editor placed in its memory for that day.

The classily named computer spends his normal day reading his internal clock against events scheduled in its memory and studying the status of sensors that the editor has placed around his house—fire and smoke detectors, security alarms, heating and cooling sensors, and so on. Breslin reads all of these very quickly—ten times a second. The editor has also hooked up soil moisture sensors to Breslin so it can tell when the lawn needs watering. And each half



This simple board is Breslin's "voice" and lets the home control computer talk up a storm, or sometimes during a storm. The board, the Computalker CT-1 Speech Synthesizer, uses parameters that represent the phonetic structure of human speech. To get your computer to say "Computalker," you use the speech synthesizer to teach it "KAA1MPYUW TAO2LKER." (Courtesy of Computalker Consultants)

hour Breslin will announce, unasked sometimes, information he's gathered during the previous half hour.

Breslin's "brains" and talking and listening abilities come from the following devices, most of which you can easily obtain through computer stores or in the mail: a Computalker speech board for speech synthesis; a Heuristics Speechlab board for voice recognition; and another board for music and sounds. The editor has a commercial Lear Seigler video monitor (normally used in businesses, but no different from most home computer monitors) and a North Star Horizon double disk drive. Add his Home Control Program, and that's the system. Anyone with a basic knowledge of home computers can easily put together such a system of his or her own. But, fortunately for most of us, we don't have to, because computer stores and dealers will show us or do it for us.

Even better, four simple systems already exist that we can just plug in and use. While they won't talk or listen to us, they will control up to 16 or more different lights and appliances, for less than $300. The control device that runs them is the same one that keeps most of Breslin working, too.

All four systems make up the beginnings of an explosion in home computer controllers. Home controls, many experts believe, present one of the two or three main chances for home computers to gain a permanent and useful place in the home. Today, home computer control systems cost as little as $300, but sophisticated systems, which can even draw a hot bath, cost up to $30,000. In between, many designers and engineers are exploring new ways to use dedicated home computers, which are as visible as a

thermostat but do almost as much work as Breslin.

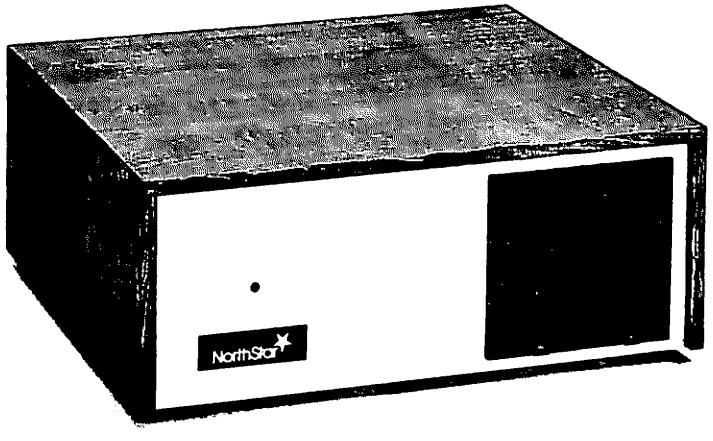
Home computers, at least microcomputers and microprocessors, have been gradually coming into the home for four years. The friendly invasion began with the microwave oven and Magic Chef, Inc., in 1976. That company turned to Texas Instruments because microwave ovens had initially suffered because of their imprecise timing and uneven heating cycles. No one liked a hot dog and bun hot at one end and cold at the other.

Texas Instruments' TMS 1000 family of four-bit microprocessors—the same family of micros used in most electronic hand-held games—solved Magic Chef's problems. In 1978, Hamilton-Beach introduced an electronic blender and a food processor with programmable timing, speed controls, and a metric-to-English measurement calculator. In the same year, Sears, Roebuck and Company introduced its Kenmore Solid-State Dishwasher, which has microcomputer controls for energy-saving cycles and other choices. Magnavox uses a Mostek microcomputer with a 2K programmable ROM and a small RAM in its televisions. RCA introduced a TV model in 1979 that can store 22 channel changes over a week. Similar microprocessors make RCA videocassette recorders programmable for up to seven days as well. Other programmable videocassette recorders use Japanese microprocessors. And many home appliance spokesmen believe that the day of the switch or the channel changer will soon give way to touchpad, calculatorlike keypads on every TV and home appliance.

They are probably correct, as consumer appliance companies introduce new programmable appliances every month. While they concentrate on adding inexpensive, small, dedicated microcomputers to existing appliances, home computer companies look toward a more distant horizon: a time when every home has a Breslin.

BSR X-10 Home Controller

The most popular home controller on the mar-

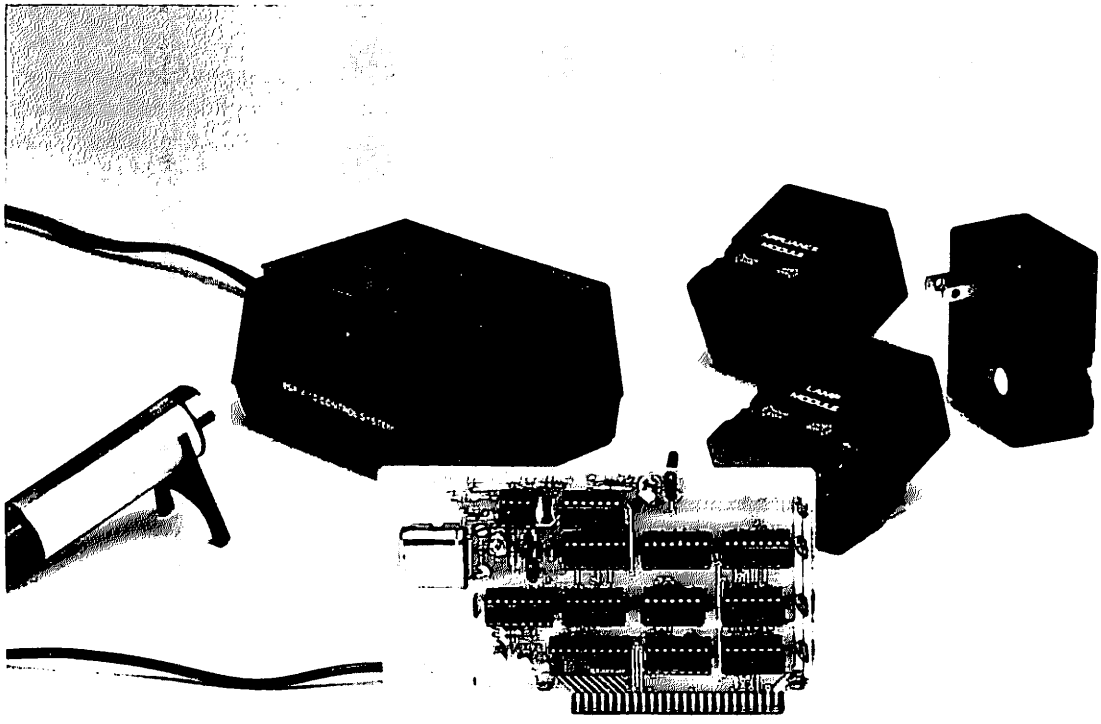


The North Star Computers double disk forms another essential part of Breslin. It will run the program that Breslin's "father" created, and act as Breslin's thoughts and direct its actions. Yet it is not a special piece of equipment; it is an advanced piece of equipment anyone can use with the knowledge gained by reading this book. (Courtesy of North Star Computers)

ket, while not a home computer, can be connected to home computers. Called the BSR System X-10, the controller works through remote control ultrasonic signals sent from a command console along a home's electric wiring to three types of special modules plugged into each outlet. The console plugs into any 120-volt AC outlet, and each of two modules, one for lamps and one for appliances, receives signals through the outlets into which they're plugged. The third module, a wall switch module, can be installed just like any normal wall switch light-dimmer, and the command console can turn the switch off or on, or dim and brighten the room. An optional cordless controller sends signals to the command console from up to 30 feet away. The X-10 has been touted on television. Radio Shack has bought it to sell through their normal outlets. The price is very reasonable—as little as $40 for the basic unit and several modules, and about $15 each for additional modules. The X-10 can control up to 16 different modules.

The X-10 by itself cannot be programmed and does not have a timer, but a home computer can be programmed to time the on-off cycle of these devices. Two home computer equipment manufacturers have adapted the X-10 system and added some hardware—Apple II

The uncomputerized BSR Limited X-10 wireless remote control system with its command console and separate modules for lamps, appliances, and wall switches. The photo shows Radio Shack's "Plug 'n' Power" version of the system. (Courtesy of Radio Shack)



The Mountain Hardware Introl X-10 controls the command console and up to 16 modules with an Apple II computer. The computer can be programmed to control the lights, appliances, switches, and so on in any configuration a homeowner wants. (Courtesy of Mountain Hardware)

and the new Ohio Scientific Challenger C8P DF, "Home Computer of the Future."

INTROL X-10

Mountain Hardware, Inc., of Santa Cruz, California, has designed a controller board, INTROL X-10, that sends signals with an ultrasonic transducer to control the X-10 command console. The controller board fits into any Apple II peripheral slot and includes a crystal-controlled timer.

It provides disk-based software that features a set-up routine so that you can define lamp and appliance wattages, set schedules and save them in the disk memory, name the appliances, and list a detailed configuration of the system. You can set daily or weekly schedules, or determine an exact date and schedule regular or random on-off cycles over a period of time. Another feature carries out your instructions, and the video screen will display all of these functions and features, in addition to wattage used in kilowatt hours for energy conservation.

Mountain Hardware charges just $279 for the controller board with the timer and transducer, a command console, two lamp modules, and an appliance module, or $189 for the controller board and the timer. Additional modules cost $15 each.

One useful option, Mountain Hardware's Apple Clock,® provides "foreground/background" operation. That is, a user can run regu-

lar programs over his or her Apple II while the controller/console continues its operation. The Apple Clock can synchronize very rapid computer signals so that they do not overlap or interfere with each other to make simultaneous operation possible.

The Apple Clock board keeps time and dates in 1/1000 second increments for over 388 days without resetting. Programs for calendar and clock routines and a timer are included in the Apple Clock's ROM, and it has an "interrupt" feature that can be programmed. The clock has many useful applications in addition to the simultaneous operations of the home controller. It can program morning printouts or displays of your appointments; create elapsed-time games; set dates for future computer transactions; and so forth. As you can see, many of these calendar and clock features were included in Breslin with a different home computer. The clock board costs $199.

A Giant Step Forward

The Ohio Scientific Challenger C8P DF takes a giant step forward from both the simple X-10 and the Mountain Hardware peripheral. It is the first home computer to include an interface for AC controls as standard equipment, and when it has an optional voice I/O system, including a Votrax speech synthesizer, and an optional Universal Telephone Interface, the computer can dial any telephone number, including a police or fire department when its home control system detects a fire, a burglary, or other event that sets off its smoke detector or burglar alarm. The C8P DF can also answer calls, communicate with touch-tone digital signals, and "speak." It can also hook up to a regular telephone modem.

More importantly, the C8P DF does not need an additional clock/calendar interface like the Apple Clock. It contains a real-time clock and can monitor its home controls while a user operates it as a conventional home computer. That is, its foreground-background capability comes as part of the package.

The C8P DF has eight input/output slots, including the complete telephone interface and interfaces for the controller, a printer, a disk drive, and other devices.

Ohio Scientific has adapted BSR's X-10 system with a built-in interface, so that one can use the computer's keyboard to give orders to the command console. And its real-time clock can perform countdowns, give time of day, and measure elapsed times.

The C8P DF also comes with a wireless home security system with two different versions. One uses single-zone sensors, which sound a general alarm regardless of the location of an emergency; the second is an eight-zone detector to which one can hook up eight different smoke detectors or burglar alarms.

By the end of 1981, Ohio Scientific will offer as peripherals for this system a new voice synthesizer and more AC remote control capabilities. In 1982, the company plans to introduce a 16-bit home computer that will be twice as powerful as the C8P DF.

The C8P DF can do more than any other home computer at present in controlling home appliances. The system, with a base price of $2,600, includes a full keyboard, an advanced BASIC interpreter, 16 colors, sound output, a voice and music convertor, joysticks, two eight-inch floppy disk drives (as standard equipment), and a large software library. (See Chapter 6 for more details.)

The X-10 command console, four modules, and required software costs an additional $175, and one wireless smoke detector is included in the package.

While Ohio Scientific's C8P DF remains the most versatile home control computer today, a new development may turn the whole home control situation upside down within months. A true home control computer would regulate stove temperatures, shower-water temperatures, light switches, solar heaters, intercoms, door-

bells, burglar alarms, smoke detectors, furnaces, locks, stereos, and so forth. Several such home control computers do exist, and many hobbyists have built their own. But the home computer industry is developing a "home bus" standard, which involves transmitting digital signals through FM waves over the AC wires in the home. Each appliance would have a decoder either built in or plugged in (like the X-10), and each appliance would interpret the signals and in turn send signals back to the computer and the other appliances, something the X-10 system does not do. A home computer plugged into normal home wiring would become the major controller of all other appliances with decoders. Such systems are already very popular in large industry to control industrial processes and manage energy conservation. But no one has yet made it economical for the home on a commercial basis.

Although Radio Shack is marketing the BSR X-10 system through its normal outlets, it has not yet made an interface so that the X-10 will work through its TRS-80 computer. Company spokesmen predict that such an interface will be available by mid-1981, if not sooner.

Home Computer in the Wall

While the X-10 interfaces and the C8P DF controller represent a way for free-standing home computers to act as home control equipment, Paul Pimentel and Steven Rudnick have tried an entirely different way, one perhaps more important for the future. Pimentel designs unique solar homes that combine the benefits of active and passive solar heating (*passive* means using sunlight shining directly on a house). They use a dedicated home computer called SMR, which Rudnick designed to run their many systems for conserving and using solar heat. This computer is basically a MOS Technology 6502 microcomputer, the same one used in the Apple II, with the programs that operate the controller in BASIC language and stored in RAM memory. It has an LED display and small keyboard which have been installed in Pimentel's kitchen wall. The home computer part of the system has been attached to a wall in the basement.

Rudnick has written that the SMR Computer was especially designed to incorporate energy-saving features, but it also has a two-stage security system that works with a large number of commercial sensors. A homeowner has complete control over the system and can change its functions at any time; he codes commands and enters instructions in such a way that breaking the codes is virtually impossible unless you know the programming.

The SMR computer can also be programmed to control other home appliances to simulate occupancy, turn on coffee, and water the lawn on hot days (but not on cool days). The energy-saving controls do the jobs that save the most money. "In [Pimentel's] house and in the houses of the future, heating and cooling are provided by the sun and an array of pumps, fans, valves, and tanks that together don't cost very much to operate if they are carefully controlled," Rudnick has said.

He notes that the cheapest source of heat is sunshine coming in through windows. The SMR computer senses when sunshine is available and arranges motorized window-insulating shades. They will automatically open to let sunlight in during winter and close to keep out sun during summer. As the south side of the house (the warmest side) warms up and the north side remains cool, the computer will transfer excess heat from one part of the house to another. If the windows let in more heat than is needed, the computer will run pumps to capture the heat and store it in a water tank. Later, when the sun goes down, the computer will run the system in reverse and use the stored heat when and where it's needed.

The computer controls its window shades with a series of thermistors, electrical relays, solenoids, gears, and small motors. The computer measures inside and outside temperatures and

air flows to determine whether the passive solar or regular home heating system should operate. It automatically controls eight Window Quilts® made of mylar sheathing and a polyester down filling. (Pulleys and gears linked to the computer raise or lower the quilts with a simple reversible gear motor.)

The storage tanks will also gather heat from the sun through solar collectors on the roof of the house. The computer senses when the sun is hot enough to heat the tanks and captures available heat each day. One tank is large and stores heat at relatively low temperatures for long periods, while the other is smaller and keeps water at a higher temperature for daily activities, such as bathing and dishwashing.

Computer-controlled heat pumps provide back-up capacity for solar systems in cold climates, but usually the computer uses the heat pump to heat up the small storage tank. Finally, the SMR computer controls the production of hot water for domestic use: first, from solar sources; second, from available stored heat; and only as a last resort, a back-up hot water heater.

Its security system uses 24 simple contact closure sensors attached to each window and door and a standard burglar alarm. Pimentel says he saved more than $150 using the computer to control the security system. He also turned his swimming pool into a huge solar storage tank, insulating it with six inches of foam at the time it was built. The combination of the storage tank pool and the computer enabled him to reduce the square footage of space the solar collectors required from 750 square feet to only 480 square feet, saving him hundreds of dollars in collector costs.

The house is divided into two physical zones and four time and temperature zones. Each zone can be reset by hand at the kitchen console. Operating the whole system, Pimentel says, requires no knowledge of computing. If you can set a digital clock radio, you can operate this sophisticated home control system with no trouble at all. Of course, any homeowner could do all of this by hand, but that would be very inefficient—who would run it when no one was home? Pimentel and Rudnick estimate that the computer system will pay for itself in less than five years. They also estimate that in mass production, the SMR home control computer would cost as little as $200, not including the solar heating equipment or heat pump.

Pimentel's and Rudnick's home control computer fulfills the requirements for systems that people will use in the future. They save money, they conserve energy, they work without requiring constant attention, and they require no knowledge of computing or computers.

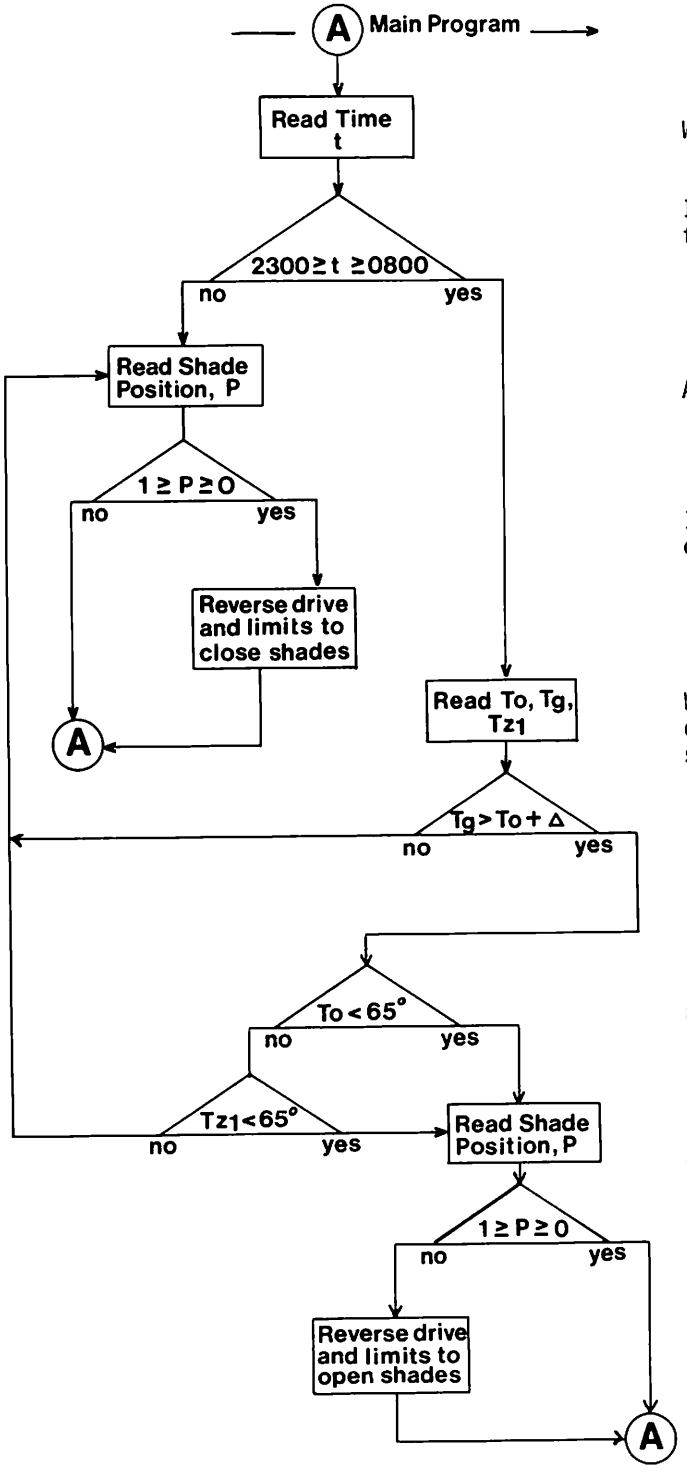
Pimentel refined his first model in early 1980 and plans to launch a larger test in a new large subdivision in the South in 1981. He may be reached for inquiries at: Sensitive Structures, 75 Federal Street, Box 2266, Boston, MA 02107. Rudnick may be reached at SMR Electronics, Three Haven Road, Medfield, MA 02062.

Other Sophisticated Home Control Computers

Another sophisticated, convenient home control computer system is made by Harris Labs in Marshalltown, Iowa. Based on the Texas Instruments 9900, 16-bit microcomputer family—the same one in the TI 99/4 home computer—the Harris system can also operate solar collectors, draperies, lighting, electrical outlets, and so forth.

The Harris system uses small touch-sensitive switches instead of standard light switches and has a central control panel that can control all the lights. Different secondary controls can be installed to turn on a bank of lights, such as all outside lights, with one switch. It has a 20-character LED display and touch-sensitive keyboard switches in place of a video terminal and keyboard. It uses four 4K EPROM chips to store the operating system, applications software, and required tables. Anyone can use the

Opposite Page: Flowchart of the computer logic that operates the Window Quilts in Pimentel's and Rudnick's computerized solar home.



What time is it?

Is it an appropriate time for the shades to be up?

Are the shades up now?

If they shouldn't be up, close them.

What are the temperatures outside, inside and at the south windows?

Is the sun out?

Is it likely the house will need heat today?

Does the house need heat now?

Are the shades up now?

If they should be up, raise them.

WINDOW QUILT CONTROL Logic

Harris system by making a simple entry that makes a permanent change in the special erasable programmable memory. But the system is not meant to be changed often, and its inventor, Laurence Harris, hopes its set-up-and-go nature will enhance its market. The Harris system, first offered in mid-1979, costs $3,500 and up, and adding more switches and master control can significantly increase the price.

A Brea, California, company, Hometech Computers, produces a system more involved and more expensive than the Harris or SMR systems. It sells for about $7,000 including sensors and installation. Like the SMR system, Hometech uses a zone temperature management system that recirculates warm air to equalize temperatures. It works through a standard Intel 8085 microcomputer, comes with a standard keyboard and video terminal, has a 15K ROM and a 1K RAM, and requires RS-232 interfaces in every room. The Hometech system uses sensors attached to any device controlled by the computer, which back up the signals from the computer. For example, if the computer instructed the coffeepot to turn on, but the pot had no water in it, a sensor would not let the pot turn on. The sensor would keep it off unless it detected a certain level of water.

The security aspect of Hometech's system is especially effective. It can not only send the police an alarm if a burglar breaks in, but it also flashes the location of the intrusion on its screen so that a family can flee or look for the burglar—unless the burglar comes into the room where the video terminal is sitting. But even home computers can't be in the right place at the right time all the time!

The Hometech system is also easy to use: full menus are shown on the screen, and the user selects the part of the system program that he or she wants to change. The system is self-prompting so that a user doesn't have to study manuals or know anything but the simple basic instructions.

All of these systems—Harris, Hometech, and SMR—amply illustrate the home of the future. If you want the home of the future today, you should see Retina, Inc.'s complete system. For between $8,000 and $30,000, Retina will install a computer that is programmed to handle heating, cooling, lighting, and so on and automatically change the thermostat and other mechanical systems.

Like computers in *Star Trek,* the Retina computer will follow your progress around the house, turning on lights as you enter a room and turning them off as you leave. It will even draw you a hot bath and regulate the water temperature. And in its spare milliseconds, it can program and operate other computers.

These home control computers, from the Mountain Hardware controller to the Retina superhouse, will clearly make our home lives more convenient, easier, more pleasant, safer, and more energy conserving. But you don't have to just dream about having such a system in your home. You can have it now.

PART FOUR

The Thinking Computer of the Future

15. The Thinking Computer of the Future

MANY PEOPLE HAVE WRITTEN science fiction stories or futuristic anecdotes about what the home computer will be like 20 or 30 years from now. Frankly, the situation has changed so rapidly during the past five years and promises to change even more rapidly during the next ten that to attempt accurate predictions today seems foolhardy. Nevertheless, forward-looking thinkers have generally portrayed the future of home computers as a new electronic Utopia.

Their forecasts and crystal-ball gazing may reflect an unrealistic point of view, much like the exhibits at the 1939 World's Fair did when they predicted super airways filled with rocket-powered people transporters the size of an automobile. Similarly, the home computer prophets have predicted that every home will have a powerful voice-controlled home computer that controls every electrical appliance, light, and gadget. They have predicted that every home will have robotic servants to completely relieve everyone from monotonous tasks with electronic gadgetry operated by computers, creating a society based solely on the pursuit of leisure. They foresee completely automated factories reducing the need for manual labor, and so on.

No one can actually predict the future (though some psychics may correctly predict individual occurrences). More likely, it seems that home computers will fulfill some of those predictions but fall very short of many others. It can be said safely that home computers will completely surprise us as people find ways to use them that no one has yet considered. After all, in 1950, who would have thought that the average American family would watch television more than six hours a day, every day?

Small, Medium, and Large

As different families prefer different kinds, sizes and shapes of televisions, so families will purchase a wide variety of home computers. Some people will want a sophisticated system that will do everything from watching the children to controlling the air conditioning; others will want a home computer the size of a pocket calculator simply because they don't like machines cluttering up their homes; others will prefer home computers that give the best, most colorful, and most interactive games, simulations, and color graphics; and any other combination of personal preferences you yourself have now or can imagine.

That's already beginning to happen in the market, and when the Japanese enter the U.S. market, as they inevitably will, the trend will accelerate. In hardware, as much as some people want to deny it, home computers will become increasingly standardized. Different microprocessors will still give each machine different capabilities, but standard interfaces will emerge so that each home computer can communicate with almost all other home computers and accept standard peripherals. Many industry leaders fear that standardization will kill the home computer industry. To the contrary, though it may force a lot of small companies out of business, it will create a boom in the consumer markets.

Lack of standardization already prevents many an average person from devoting the time and thought necessary to deciding what computer he wants to buy. Radios, televisions, stereos, and other gadgets follow the same standards, and their industries certainly haven't suffered in the past 20 years. A customer can walk in and take any one of them off the shelf and know that he can take it home, plug it in, and use it without worrying about whether he can understand it or get it fixed. Standardization in home computers will eventually help create the same consumer confidence.

In addition, as much as one industry leader denies it, the trend toward miniaturization cannot be denied. The Sinclair microcomputer and the HP-85, as we've seen, pack more punch into a book-sized computer than the first home computers packed into carton-sized black boxes. A point of diminishing returns does exist, but, as in TVs and calculators, no one can begin to imagine where it will end in home computers. Obviously, as companies cram hundreds of times more memory and processing power onto a chip, home computers will get smaller and smaller. By 1995, if not long before, a powerful home computer the size of a business card or the shape of a ballpoint pen could help you do business. Many factors, such as economical pricing, will influence miniaturization, but production techniques to take advantage of the trend already exist.

Home computers will undoubtedly create sizable new industries, particularly a service industry to produce software. The real power of a computer lies not in its configuration, but in what people can use it to do. So far, most have used it mainly to play games. We will continue to do so because we like to play games and entertain ourselves, but software manufacturers have begun to discover all the other ways to use home computers. In 1979 and 1980, they discovered small business: providing software for the millions of small businesses will continue to be an important, growing segment of the home computer market. But while there are about 15 million small businesses, there are more than 70 million homes that would use a computer. And there are over 200 million people, too, most of whom would want a home computer in their pockets, much like people now carry calculators wherever they go—to school, work, or entertainment. Miniature home computers that people slip in their pockets or purses as easily as a wallet must be considered a logical outgrowth of the pocket calculator boom.

Home Controllers

The home computer-in-the-wall we discussed in Chapter 14 merely hints at what the future will hold. A dedicated home computer can control any kind of electrical or electronic device. As Paul Pimentel has said, when home builders can spend $200 to install an intercom-sized dedicated home computer that adds $2,000 to the value of a house, they will do so. Home buyers will snap up—and homeowners will quickly add—dedicated home computers that pay for themselves in energy savings in less than five years. These dedicated home controllers will become as much a part of a new house as a dishwasher or air conditioning, will cost far less to operate, and will do so much more.

While a home controller puts your appliances through their paces, the appliances themselves will work much more intelligently. Within five years, every home appliance for sale will contain a microprocessor—everything from the toaster to the telephone will have a microprocessor that will allow you to program it. Digital telephones, of course, are already here; they enable buyers to store dozens of phone numbers, dial automatically, tell the time, use it as a calculator with memory, and so forth. Only a psychological barrier felt by many consumers stands in the way of every home's having these appliances.

Home Computer Networks

A large consulting company, Arthur D. Little,

Inc., estimates that by 1992, 8 million homes will have Viewdata services, while two or three times that many could have Teletext services (or Videotext as the French call it). Those estimates may prove conservative, if, again, industry can set standards for these transmissions and reduce the price or decoders, like Texas Instruments' TIFAX, to less than $100.

European activities provide one view of the way the future may look. The French, with their Antiope system, have planned a ten-year program to eliminate the printed telephone directory and add an electronic one that works through Videotext. AT&T in this country has tested a similar idea in Albany, New York. Dozens of broadcasters, electronics manufacturing giants, telephone companies, and many more are poised to launch these and all other Teletext and Viewdata services. When they do it depends more on the economic situation and consumer attitudes than on technology.

One observer believes that these services must provide a mixture of free and paid information to appeal to the widest audience and offer shopping-at-home and other electronic transactions—such as banking—to economically justify home information services. That would mean that advertisers would use the services as a new medium for selling consumer goods and services.

The most important tests have ended, and we will soon know the results. After the market analysis, one can expect the communications giants to take two to three years to agree on standards, begin mass production, and get their new information services into the hands of the public.

Conferencing networks like EIES and the community bulletin boards will also grow in number, and probably will have great social impact if millions of people begin working together over long distances. Professionals could do almost all their work at home, transmitting it through terminals; business conferences and committees could meet at their leisure through televised or computerized networks; and so on. Families could stay in closer communication if children could send a message whenever they wanted to. The handicapped could interact with their world in unique and positive ways. Computer conferencing networks could easily break down enormous social barriers for the handicapped and anyone else by helping individuals quickly find many other people with similar interests. One member can send out a message over a network asking if another member is interested in Picasso, chamber music, or rare books, and find dozens of others with whom to share that interest. The hit-and-miss of "lonely hearts" classified advertisements might disappear because a member could instantly find a compatible someone who was trying to get in touch with him.

Networks, home information services, and other services in fact already exist. What doesn't exist, and the effects of which we can't gauge, are several developments that I believe will make or break home computers: voice recognition, speech synthesis, and touch-sensitive terminals. These steps are still in their infancy. Yet, by 1990, home computers will readily talk to you in plain English, understand complicated English sentences, and respond to your touch on their screens. Home computers of the future will not have keyboards as we know them. The Japanese have adequately demonstrated their expertise in this field. The home computer of the future may look like an intercom set in the wall of a house. It may have a small LED or LCD screen, but no buttons except an on-off switch. Its owner will carry on simple, explicit conversations and the computer will respond.

In another variation, as Information Dialogues, Inc., Minneapolis, Minnesota, is showing, people feel more confident about computer screens that they can touch and get information from. Touch-sensitive terminals make home computers completely interactive and require no knowledge of typing, commands, programming, or computer operations at all. The computer does it all. The Information Dialogues current touch-sensitive terminals consist of an

8-inch-by-10-inch screen covered with touch pads. Touch pads divide the screen into right and left halves; each half is overlaid with several ⅜-inch-by-5-inch touch-sensitive horizontal strips, each separated by a small gap. Each strip is made of clear plastic overlying a transparent metallic sheet. A small box sends an oscillating current into each strip. When someone touches a strip, the flow of electrons across the strip changes, and the computer terminal detects the change and relays a signal to the computer. Some companies use photocells, and some use surface electronic waves, instead of touch pads.

In any case, the signal to the computer matches exactly the number, letter, word, or symbol on the screen. The computer then executes that choice. In fact, the user touches one choice in a menu of choices. The computer will either display the sought-after information, carry out a computation, or display information and offer another menu. The user continues to touch whatever information he wants on the display and continues to interact with the computer in an intimate and unbelievably easy way.

The touch-sensitive terminal technology, though in its infancy, promises to be extremely important to home computers as the capability improves and the prices come down. Experiments have shown touch terminals to be especially pleasing to children and also valuable in computerized learning aids.

Touch terminals, dedicated home controllers, home computers, conferencing networks, home information services—although no one can accurately predict what's going to happen tomorrow, one thing is for sure: in some extraordinary fashion, the home computer will help you live your life more easily, more pleasurably, and more intelligently than ever before.

APPENDIX

1,050 HOME COMPUTER PROGRAMS

Aladdin Automation, Inc.
3420 Kenyon Street, Suite 131
San Diego, CA 92110

CATEGORY: GAMES

Math-Ter-Mind
Lunar Lander
Craps
Mastermind
Tic-Tac-Toe
Jungle Island
Stix
Super Pro Football

APF Electronics, Inc.
444 Madison Avenue
New York, NY 10022

Imagination Machine Software

CATEGORY: EDUCATIONAL

Typing Tutor
Math Tutor
Perception I
Space, Size, and Surface Guide
Spelling Duel
The Word Factory
Basic Tutor
Computer Lab

CATEGORY: GAMES

Artist and Easel
Music Composer/Player Piano
Adventure Castle
Billboards

CATEGORY: PERSONAL-FINANCIAL

Checkbook/Financial Manager
Personal Business Machine
Budget Manager II
Electronic Files

CATEGORY: MISCELLANEOUS

Bar Charts

Apple Computer, Inc.
10260 Bandley Drive
Cupertino, CA 95014

CATEGORY: COMPUTER LANGUAGES

Pascal (for 48K Apple II)
Compiler
Relocatable Assembler
Applesoft II Floating-Point BASIC Language
Integer BASIC
Programmer's Aid #1

CATEGORY: PERSONAL-FINANCIAL

General Business System (GBS I)
The Controller
Point of Sale
Apple Post (for 48K RAM dual disk drives, Applesoft BASIC, Printer 11A)
Dow Jones Series:
Stock Quote Reporter
Portfolio Evaluator
News Reporter
Checkbook with Financial Data Base Management
File Cabinet

CATEGORY: EDUCATION

Colormath
Hangman
Mastermind
The Infinite Number of Monkeys
Engine
The Great American Probability Machine
California Driving Test
Hammurabi (1)
Morse Code (1)
Don't Fall
Match Machine
Professor True
Mr. Multiple

CATEGORY: SCIENTIFIC CALCULATION

Bone Tumor Differential Diagnosis
Airoil

CATEGORY: UTILITY PROGRAMS

Hi-Res Graphics
RAM Test
Datamover
Hi-Res Character Set (3)
HEX Converter
Integer Base Chr$ Function (1)
Integer BASIC Renumber and Append (5)

CATEGORY: GAMES

Apple Trek
Space War
Brick Out
Blackjack
Chase
Kaleidoscope
Mission: U-Boat
Apple Organ
Add-Libs
Shootout
Intercept

Apple-vision
Slot Machine
Biorhythm
Othello
Chess
Pinball
Sink the Ship
Catch
Curves
Seven
Towers of Hanoi
Nightmare #6
23 Bricks
Yahtzee
Magic Lantern
Intercept
Apple Bowl

Atari Personal Computer Systems
1265 Borregas Avenue, Dept. C
Sunnyvale, CA 94086

CATEGORY: GAMES

Basketball
Super Breakout
Video Easel
Music Composer
Chess
Tic-Tac-Toe
Star Raiders
Checkers
Business Simulations
Stock Market Simulation
Backgammon
Hangman
Kingdom
Mugwump
Baseball
Blackjack

CATEGORY: PERSONAL-FINANCIAL

Personal Finance
Home Finance
Record Keeping of Books, Serial Numbers, and Insurance Policies
142 Function Programmable Printing Calculator
Personal Capital Investment Management
Mailing List/Address Book
Bond Yield
Bond Price and Interest
Bond Switch
Stock Rate of Return
Stock Dividend Analysis
Stock Charting
Mortgage Analysis
Portfolio Analysis

CATEGORY: EDUCATION

Educational System Master Cartridge
Invitation to Programming
Supervisory Skills
Algebra
Economics
U.S. Government
Sociology
U.S. History
Physics
Great Classics
Business Communications
Basic Psychology
Spelling
Accounting
World History
Counseling Procedures
Basic Electricity
Effective Writing
Touch-typing Trainer

CATEGORY: LANGUAGE/TEXT EDITORS

Computing Language
Assembler Editor Computing Language
BASIC
Assembler
Pilot

CATEGORY: PERSONAL

Biorhythm

Bally
10750 West Grand Avenue
Franklin Park, IL 60131

CATEGORY: LANGUAGE

Bally BASIC

CATEGORY: GAMES

Zzzap/Dodgem
Star Battle
Sea Wolf/Missile
Bally Pinball (3 games)
Panzer Attack/Red Baron
Tornado Baseball/Tennis/Hockey/Handball
Brickyard/Clowns
Football
Demolition Derby/Grand Prix
Drag Race/Desert Fox
Bingo Math/Speed Math
Letter Match/Spell 'N' Score/Crosswords
Music
Amazin' Maze/Tic-Tac-Toe
Black Jack/Poker/Acey Deucey
Checkers/Backgammon

Commodore Business Machines, Inc.
3330 Scott Boulevard
Santa Clara, CA 95050

CATEGORY: COMPUTER LANGUAGES

Machine Language Monitor (for PET 4K and 8K)
Basic BASIC
Hands-On BASIC

CATEGORY: ENTERTAINMENT

Reversal
Number Reversal
Target Pong
Off the Wall (for 8K PET)
Lunar Lander
Rotate
Wumpus
Tic Tac Toe
Galaxy Games
Draw Poker
Blackjack
Spacefight
Spacetrek
Backgammon
Bowling

CATEGORY: PERSONAL

Diet Planner
Biorhythm

User Port Cookbook
On-the-House

CATEGORY: PERSONAL-FINANCIAL

Mortgage
Stock Maintenance
Stock Analysis
Loan Calculator
Depreciation Analysis
Savings Calculator
Rockstock
Financial Analysis
Annual Property Operating Data
Cash Flow Analysis
Installment Sale
Ardenstock
Costing
Data Base Utility
Survey Analysis
Checkbook Maintenance
Checkbook Report

CATEGORY: EDUCATION

Plane Geometry
Spherical Geometry
Analysis
Matrix 1
Matrix 2
Vector
Snake
Strathclyde Basic Course Workbook
Write-to-Read Lessons
Rhyming
Alphabetizing
Guess My Sentence
The States
Maps & Capitals
CAI Projectile Motion
II Projectile Motion
CAI Momentum and Energy
II Momentum and Energy
CAI Pulley Systems
II Pulley Systems
CAI Lenses and Mirrors
CAI Series/Parallel Circuit Analysis
II Series/Parallel Circuit Analysis
CAI The Mole Concept
II The Mole Concept
CAI Molarity Concept
II Molarity Concept
CAI Stoichiometry: General
II Stoichiometry: General
CAI Naming Compounds Drill
Costing
CAI Formulas of Compounds Drill
II Formulas of Compounds Drill
Gradebook
Gradebook Stat
Grade Curving
Time Teller
Capitalization 1
Capitalization 2
Capitalization 3
Capitalization 4
Capitalization 5
Capitalization 6
Capitalization 7
Capitalization 8
Capitalization 9

CATEGORY: TEXT EDITORS

Word Processor 1
Word Processor 2

CATEGORY: MISCELLANEOUS

Squiggle
Mandala
Graphics
World Clock
Disassembler
Machine Code Handler
HEX Editor and Loader
BASIC Math Package
Basic Statistics Package
Strathclyde BASIC Course

Compucolor Corporation
Box 569
Norcross, GA 30071

CATEGORY: GAMES

Sampler (for 8K)
Formatted Twin Pack
Othello (for 8K)
Chess (for 8K and 16K)
Star Trek (for 8K)
Blackjack (for 8K)
Cubic Tic Tac Toe (for 16K)
Sharks
Airraid
Star Trader
Swarms (for 16K)
Soundware
Shoot
Lunar Lander
Bounce

CATEGORY: PERSONAL-FINANCIAL

Personal Finance, Volume I (for 8K)
Personal Finance, Volume II
Bonds (for 16K)
Equity (for 16K)
Personal Income Tax (for 16K)

CATEGORY: TEXT EDITORS

Text Editor (for 16K)
Basic Editing (for 16K)
Screen Editor (for 16K 117 Kybd)

CATEGORY: PERSONAL

Personal Data Base (for 16K)

CATEGORY: COMPUTER LANGUAGES

Machine Language Debug Package (for 16K)
Algo (for 32K)
Pilot (for 16K)
FORTRAN (for 32K)
BASIC Language 1
BASIC Language 2

CATEGORY: EDUCATIONAL

Math Tutor (for 8K)
BASIC Tutorial, Volume 1
BASIC Tutorial, Volume 2

CATEGORY: ENGINEERING

Statistics I
Statistics II, Regression
Statistics III, Time Series

CATEGORY: MISCELLANEOUS

Assembler (for 16K)
Monitor (for 16K)
Compucolor Formatter

Creative Computing
Box 789-M
Morristown, NJ 07960

PET GAMES

Logic Games 1 (for 8K)
Logic Games 2 (for 8K)
Graphics Games 1 (for 8K)
Graphics Games 2 (for 8K)
Number Games 2 (for 8K)
Conversational Games 2 (for 8K)
Board Games (for 8K)
Action Games (for 8K)
Adventureland and Pirate Adventure (for 24K)
Sensational Simulations (for 8K)
Study Made Easy (for 8K)

GAMES FOR TRS-80 LEVEL I

Games 1 (for 4K)
Games 2 (for 4K)
Geography (for 4K)
Tape Manager/Graphics/Statistics (for 4K)
Investment Analysis (for 4K)

PROGRAMS FOR TRS-80 LEVEL II

Board Games 1 (for 16K)
Space Games 3 (for 16K)
Pursuit Games (for 16K)
Strategy Games (for 16K)
Air Traffic Controller (for 16K)
Adventureland (for 16K)
Pirate Adventure (for 16K)
Mission Impossible Adventure (for 16K)
Voodoo Castle (for 16K)
The Count (for 16K)
Ecology Simulations 1 (for 16K)
Ecology Simulations 2 (for 16K)
IQ Test (for 16K)
Social and Economic Simulations (for 16K)
Graphics Package (for 16K)
Advanced Statistics (for 16K)
Checking Account (for 16K)
Investment Analysis (for 4K)

TRS-80 DISKS

Ecology Simulations 1 (for 32K)
Ecology Simulations 2 (for 32K)
Games Pack 1 (for 32K)
Text Processing/Checking Account (for 32K)
Advanced Statistics (for 32K)
Adventureland and Pirate Adventure (for 32K)
Mission Impossible and Voodoo Castle Adventure (for 32K)
Social and Economic Simulations (for 32K)

PROGRAMS FOR APPLE II

Space Games (for 16K)
Sports Games (for 16K)
Strategy Games 1 (for 16K)
Brain Games 1 (for 16K)
Haunted House (for 16K)
CAI Programs (for 16K)
Know Yourself (for 16K)
Space Invader (for 32K)
Space and Sports Games (for 32K)
Strategy and Brain Games (for 32K)
CAI Programs/Know Yourself (for 32K)
Space Invader (for 48K)

PROGRAMS FOR SORCERER

Graphics Games (for 8K)
Smart Alec (for 8K)
Adventureland (for 16K)
Pirate Adventure (for 16K)
Mission Impossible Adventure (for 16K)
Voodoo Castle (for 16K)
The Count (for 16K)

Hayden Book Company, Inc.
50 Essex Street
Rochelle Park, NJ 07662

CATEGORY: GAMES

Batter Up!! A Microbaseball Game (for PET, TRS-80 Level II)
Mayday! (for PET)
Backgammon (for TRS-80 Level II, PET)
Gridiron (for TRS-80 Level II)
Game Playing with BASIC (for PET, TRS-80 Level II, Apple II)
Crossbow (for PET)
Songs in the Key of Apple (for Apple II)
Keynote (for TRS-80 Level II)
The First Book of KIM (for KIM-1)
Sargon II
Sargon: A Computer Chess Program

CATEGORY: MATHEMATICS

Engineering Mathematics (for PET, TRS-80 Level II, Apple II)
General Mathematics 1 (for PET, TRS-80 Level II, Apple II)
Complex Mathematics (for PET, TRS-80 Level II, Apple II)
Sketchmode
Biocurve
How to Build a Computer-Controlled Robot

CATEGORY: EDUCATIONAL

Microtyping (for TRS-80 Level II)

CATEGORY: MISCELLANEOUS

Applesoft Utility Programs (for Apple II)
Slow List/Stop List (for Apple II)
Revive (for Apple II)
Microcomputer-Aided Design of Active Filters (for PET, TRS-80 Level II, Apple II)
Renumber and Append (for Apple II)

Hewlett-Packard
Corvallis, OR 97330

CATEGORY: APPLICATION PACS

BASIC Training
Standard
General Statistics
Finance
Waveform Analysis
Math
Circuit Analysis
Games
Linear Programming
Text Editing

High Technology
1847 Dunn Road
Florissant, MO 63033

CATEGORY: ENTERTAINMENT

Micro Composer (for Apple II, 32K or 48K disk)
Digisong Pak (for Apple II, 32K or 48K disk)

Instant Software, Inc.
Peterborough, NH 03458

PROGRAMS FOR TRS-80 LEVEL I

Status of Homes/Auto Expenses
Personal Finance I
Business Package III
Fun Package I
Cave Exploring/Yacht Memory
Business Package I
Space Trek II
Car Race/Rat Trap/Antiaircraft
Knight's Quest/Robot Chase/ Horse Race
Demo I
Destroy All Subs/Bomber/ Gunboats
Doodles and Displays I
Hex Pawn

PROGRAMS FOR TRS-80 LEVEL I AND II

Electronics I
Golf/Cross Out
Oil Tycoon
Ham Package I
Santa Paravia and Fiumaccio
Beginner's Backgammon and Keno
Basic and Intermediate Lunar Lander
Bowling
Air Flight Simulation
Space Trek II

PROGRAMS FOR TRS-80 LEVEL II

Space Trek IV
Household Accountant
Bowling League Statistics System
Financial Assistant
Model Rocket Analyzer and Pre-Flight Check
Ramrom Patrol
Doodles and Displays II
Teacher
TRS-80 Utility I
TRS-80 Utility II
Cards

PROGRAMS FOR PET

Turf and Target
Tangle Super-Trap
Dow Jone$
Digital Clock
Personal Weight Control and Biorhythms
Mimic
Penny Arcade
Dungeon of Death
Casino I
Casino II
Baseball Manager
Mortgage with Prepayment Option and Financier
Arcade
Arcade II
Qubic-4 Go-Moku
Checkers and Baccarat
Trek-X
Typing Teacher
Video Speed Reading Trainer
Personal Bill Paying
Air Mail Pilot
Loan Amortization
Depreciation Schedule
Electronic Engineer's Assistant
Decorator's Assistant
PET Demo I
PET Utility Package

PROGRAMS FOR APPLE

Bowling Trilogy
Golf
Math Tutor I
Math Tutor II
Loan Amortization
Depreciation Schedule
Mortgage with Prepayment Option
Financier
Space Wars
Apple War Games

Interact Electronics, Inc.
Box 8140
Ann Arbor, MI 48107

CATEGORY: PERSONAL-FINANCIAL

Checkbook Balancer
Financial Library I
Financial Library II
Message Center
Calculator
Household Budgeting

CATEGORY: LANGUAGES

Edu-BASIC
Level II BASIC
Level II BASIC Docu-Pack
Ezedit

CATEGORY: MISCELLANEOUS

Diagnostic Tape
Data Tape

CATEGORY: GAMES

Video Chess
Interact Microchess
Backgammon
Reversi
Black Jack
Strategy Series Pack
Star Track
Music Maestro
Breakthrough
Compute-a-Color
Concentration
Add 'Em Up
Hangman
Knockdown
Regatta
Touchdown
Computer Maze
Dogfight
Volleyball
Education and Entertainment Series Pack
Trailblazers
Showdown

Mattel, Inc.
Intellivision
5150 Rosencrans
Hawthorne, CA 90250

CATEGORY: GAMES

Major League Baseball
NFL Football
Auto Racing
Tennis
Skiing
PGA Golf
NASL Soccer
NHL Hockey
Boxing
NBA Basketball
Backgammon
Checkers
Armor Battle
Sea Battle
Space Battle
Math Fun
Word Fun
Poker and Blackjack
Roulette
Horse Racing

CATEGORY: PERSONAL-FINANCIAL

J.K. Lasser's 1981 Federal Income Tax Preparation Stock Analysis

CATEGORY: PERSONAL

Jack LaLanne's Physical Conditioning
Jeane Dixon Astrology
Dr. Art Ulene Weight-Loss Program

CATEGORY: EDUCATION

Guitar Lessons and Music Composition
Speed Reading
Conversational French

Ohio Scientific
1333 South Chillicothe Road
Aurora, OH 44202

CATEGORY: EDUCATIONAL

Math, Spelling, Geography Tutors/Addition Game
Beginning BASIC
Trig Tutor, Presidents, Continents, Solar System
Trig Functions, Logarithmic Functions, Matrices
Metric System, Roman Numerals, Time Telling
Advanced Sciences (2-disk set), Nuclear & Organic Chemistry, Genetics, Physics, Equations, Function Graphics
Alphabet Tutor (color and b&w)
Language Disk—Vocabulary and Verbs for German, French, and Spanish
Word Search Game and Hangman
Educational System—create your own quizzes

CATEGORY: PERSONAL-FINANCIAL

Ratio Analysis, Bonds, Loan Interest, Bar Graph
BASIC Word Processor, Mailing List, Address Book
Annual Histogram Plotting and Editing
Mini Data Base Management System
Auxiliary 1 Repack
Accounts Payable Update, Vendor List, etc.
Accounts Receivable Update
Inventory
Payroll
Mailing List
Checking, Savings Accounts
Personal Calendar/Address/Phone Book
Word Processing (mini-floppy)

CATEGORY: GAMES

Star Wars, Hectic, Bomber
Sketch, Racer, Destroyer
Star Trek, Cryptograms, Blackjack
Frustration, Battleship, Tic-Tac-Toe
Baseball, Golf, Bowling
Poker, Blackjack, Spades
Joystick Sketch, Tiger Tank, Roadrace (for joystick systems only)
Zulu 9, High Noon, Star Wars (for joystick systems only)
Othello, Concentration, Flip-Flop
Cartoons, Fairy Tales, Animations (2-disk set)

CATEGORY: PERSONAL

Annuities, Rate of Return, Biorhythms, Calorie Counter
Trend Line, Base Conversions, Powers, Integrals

CATEGORY: UTILITY

Auxiliary 1 Resequence, BASIC Disassembler, Sort
Graphics 1
State-of-the-Art Music Generation
Advanced Home Control Programs

Queue
5 Chapel Hill Drive
Fairfield, CT 06432

Queue and its affiliate, Queue Consulting Services, Inc., offer comprehensive catalogs of educational software and teach educational institutions how to use home and personal computers in the classroom, including computer-assisted instruction (CAI) and how to use computers. It has become an important, one-stop source for almost all current educational software written by many software publishing houses for the most important home and personal computers. It has granted permission for the reproduction of their early 1980 catalog here. They will publish a new catalog, which may have more than twice as many listings as this one, in late 1980.

Before each listing, the name of the software house that developed the program is given in parentheses.

PROGRAMS FOR APPLE II

(*George Earl*)
10 Mother Goose Rhyme Programs (cassette or diskette)
6 Favorite Guessing Games—Cities, Capitals, etc. (cassette or diskette)
Spanish (cassette or diskette)
10 Readings in Literature (cassette or diskette)
The George Earl Sampler (cassette or diskette)
10 Lessons in Algebra
IQ Builder Series—Math
(*Program Design, Inc.*)
Spelling Builder
Preschool IQ Builder
Step by Step
The Teaching Machine
Code Breaker
Minicrossword
IQ Builder Series
(*Muse Co.*)
Uncle Sam's Jigsaw
Appilot
(*Instant Software, Inc.*)
Math Tutor I
Math Tutor II
(*Cavri*)
Cavri System

PROGRAMS FOR PET

(*Program Design, Inc.*)
Word Skills 1: Prefixes
Reading Comprehension
Preschool IQ Builder
Step by Step
The Teaching Machine
Code Breaker
IQ Builder Series—Vocabulary
Memory Builder: Concentration
Story Builder/Word Master
Morse Code Game
IQ Builder Series
(*Microphys*)
Vocabulary Programs—12th Grade
Vocabulary Programs—11th Grade
Vocabulary Programs—10th Grade
Vocabulary Programs—9th Grade
Vocabulary Programs—8th Grade
Vocabulary Programs—7th Grade
Senior High Vocabulary Diskette
Junior High Vocabulary Diskette
Spelling Programs—Grade 12
Spelling Programs—Grade 11
Spelling Programs—Grade 10
Spelling Programs—Grade 9
Spelling Programs—Grade 8
Spelling Programs—Grade 7
Linear Kinematics
Projectile Motion
Momentum and Energy
Energy and Inclined Plane
Inelastic Collisions
Centripetal Force
Pulley System Machines
Calorimetry
Specific Heat Capacity
Heats of Fusion/Vaporizaton
Specific Gas Laws
General Gas Laws
Thermodynamics
Thermodynamics II
Transverse Standing Waves
Longitudinal Standing Waves
Mirrors and Lenses
Refraction of Light
Series Circuit Analysis
Parallel Circuit Analysis I
Parallel Circuit Analysis II
Series/Parallel Circuit Analysis
Faraday's Law
Gram-Molecular Mass
The Mole Concept
The Molarity Concept
The Normality Concept
The Molality Concept
Stoichiometry: Mass/Mass
Stoichiometry: Mass/Volume
Stoichiometry: Volume/Volume
Stoichiometry: General
Percent Concentration
pH Concept
EMF of Electrochemical Cells
Electric Field Analysis
Photoelectric Effect
Symbols and Valences Drill
Naming Compounds Drill
Formulas of Compounds Drill
Total Internal Reflection
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Physics II Diskette
Chemistry I Diskette
Chemistry II Diskette
Number Series
Senior High School Mathematics Programs
Trigonometry I
Simultaneous Equations
Simultaneous Equations (3×3)
Geometrical Areas
Trigonometry II
Verbal Problems I—Numbers
Verbal Problems II—Coins
Verbal Problems III—Ages
Verbal Problems IV—Interest
Verbal Problems V—Mixtures
Verbal Problems VI—Geometry
Verbal Problems VII—Rates
Verbal Problems VIII—Digits
Verbal Problems IX—Work
Arithmetic Progressions I
Arithmetic Progressions II
Geometric Progressions I
Geometric Progressions II
Types of Variation
Linear Equations
Formula Evaluation
Coordinate Geometry
Exponents and Logarithms
Verbal Problems X—General
Magic Squares
Multiplication
Division
Modular Arithmetic
Proportion Problems
Percent Problems
Addition of Fractions
Subtraction of Fractions
Multiplication of Fractions
Division of Fractions
Mode, Median, and Mean
Bar Graph Analysis
Decimals I
Decimals II
Junior High Math Diskette

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Division Drill
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Decimals
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Change Maker
Projectile

PROGRAMS FOR TRS-80 LEVEL I, 4K

(*Program Design, Inc.*)
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IQ Builder Series
IQ Builder Series—Math
Graph Builder
(*Mad Hatter Software*)
Pilot 1.0 for TRS-80

PROGRAMS FOR TRS-80 LEVEL II, 16K

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Spelling Builder
Preschool IQ Builder
Step by Step
The Teaching Machine
Minicrossword
IQ Builder Series
Memory Builder: Concentration
Story Builder/Word Master
Astro Word Search
IQ Builder Series
Graph Builder
(*Micro Learningware*)
Revolutionary War Quiz
Country
Regions of the U.S.
Presidents
Sets and Numbers
Place Value
Number Strings
Math Drill
Division Drill
Fractions
Decimals
Factor
Speed Drill
Metric Blackjack
Metric Roadrunner
Plot
Accounting I
Accounting II
General Ledger
Change Maker
Projectile
(*Mad Hatter Software*)
Pilot 2.0
(*National Software Marketing*)
Tutorial I—Elementary Algebra
Tutorial II—Elementary Trig
Tutorial III—Elementary Geometry

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Fort Worth, TX 76102

TRS-80 Library of Ready-to-Run Software

CATEGORY: BUSINESS-RELATED SOFTWARE

Tape Mailing List (for 16K and 32K) (16K Level II required)
Disk Mailing List (for 16K disk)
Business Mailing List (for 32K disk)
General Ledger I (for 32K disk)
Inventory Control I for 32K disk)
Manufacturing Inventory Control I (for 32K disk)
Accounts Payable (for 32K disk)
Accounts Receivable (for 32K disk)
Fixed Asset Accounting (for 32K disk)
Time-Accounting Package (for 32K disk)
Disk Payroll (for 32K disk)
Level I Cassette Payroll (for 4K)
Level II Cassette Payroll (for 16K or 32K disk)
Real Estate, Volume I (for 16K, Level II)
Real Estate, Volume II (for 16K, Level II)
Real Estate, Volume III (for 16K, Level II)
Real Estate, Volume IV (for 16K, Level II)
Real Estate, Volume V (for 16K, Level II)
Statistical Analysis (for 4K, Level I)
Advanced Statistical Analysis (for 16K, Level II)
Concrete Take-Off (for 32K disk)
Word Processor Disk (for 32K disk)
Word Processor Cassette (for 16K, Level II)

CATEGORY: FORTRAN AND ASSEMBLY LANGUAGE SOFTWARE

TRS-80 FORTRAN (for 32K disk)
Disk Editor Assembler (for 32K disk)
Editor Assembler (for 16K, Level I or II)
T-Bug (for 4K, Level I or II)

CATEGORY: COMMUNICATIONS

RS-232C Communications Software (for 16K, Level II)

CATEGORY: PROGRAMMING AIDS

Renumber (for 4K, Level II)
Double Precision Subroutines (for 4K, Level II)

CATEGORY: PERSONAL

In-Memory Information (for 4K, Level I or II)
Personal Finance (for 4K, Level I)

Budget Management
(for 16K, Level II)
Cassette Portfolio Analysis
(for 16K, Level II)
Standard & Poor's Portfolio
Management and Security
Selection System (for 32K disk)

CATEGORY: EDUCATIONAL

Math I (for 4K, Level I)
I.Q. Builder (for 4K, Level I or II)
Level I BASIC Course
(for 4K, Level I)
Level II BASIC Course, Part I
(for 4K, Level II)
Level II BASIC Course Part II
(for 16K, Level II)
Disk BASIC Instruction (for 16K
disk)
Teacher Aide (for 16K, Level II)
TRS-80 Hands-On BCL
(Basic Computer Literacy)
Package (for 4K, Level II)

CATEGORY: GAMES

Blackjack Backgammon
(for 4K, Level I or II)
"Quick Watson" Deduction Game
(for 4K, Level I or II)
Games Pack I (for 4K, Level I)
Casino Games Pack
(for 16K, Level II)
Micro Chess (for 4K,
Level I or II)
Micro Movie (for 16K,
Level I or II)
Micro Marquee (for 4K,
Level I or II)
Micro Music (for 4K,
Level I or II)
Flying Saucer (for 4K,
Level I or II)
Invasion Force (for 16K,
Level I or II)
Checkers 80 (for 16K,
Level I or II)
"Eliza" Artificial Intelligence
(for 16K, Level I or II)

Rainbow Computing, Inc.
9719 Reseda Boulevard
Northridge, CA 91324

Rainbow Computing also sells programs prepared by other companies. These companies are noted in parentheses before each listing.

CATEGORY: DEMONSTRATION

(*Programma International*)
3-D Animation (for Apple 48K,
BASIC, Assembly)
Kaleidoscope (for Apple 16K,
Applesoft II)
Perpetual Calendar (for Apple
16K)
Talking Disk (for Apple 2K,
BASIC, Assembly)
Time Clock (for Apple 16K)
(*Softape*)
Apple Listener (for Apple 16K,
Assembly)
Apple Talker (for Apple 16K,
Assembly)
Music Kaleidoscope (for Apple
16K, Assembly)
Talking Calculator (for Apple
16K, BASIC, Assembly)
Tic Tac Talker (for Apple 16K,
BASIC, Assembly)
(*Rainbow Computing*)
Applevision (for Apple 16K,
Assembly)
Hi-Res Life (for Apple 24K,
Assembly)

CATEGORY: EDUCATION

Audio Engineer Disk (for Apple
32K, APPLESOFT II)
(*Rainbow Computing*)
Circuit Logic Development Aid
(for Apple 16K)
Morse Code Trainer (for Apple
16K, APPLESOFT II)
Polar Plot (for Apple 24K, BASIC,
Assembly)
(*Programma International*)
Compu-Read (for Apple 32K,
BASIC, APPLESOFT II)
Scramble (for Apple 16K)
State Capitals (for Apple 16K)
(*Edu-Ware*)
Perception I (for Apple 32K and
48K, APPLESOFT II)
Perception II (for Apple 24K and
48K, APPLESOFT II and
ROM)
Perception III (for Apple 24K and
32K, APPLESOFT II)

CATEGORY: ENTERTAINMENT

(*Programma International*)
3-D Docking (for Apple 16K,
Assembly)
Ack-Ack (for Apple 16K)
Assist-It (for Apple 16K)
Battlestar I (for Apple 32K)
Camera Obscure (for Apple 16K)
Canter Downs (for Apple 16K)
Chase (for Apple 16K)
Color Startrek (for Apple 16K)
Coney Island (for Apple 16K)
Country Driver (for Apple 16K)
Cross Chase (for Apple 16K)
Depth Charge (for Apple 16K)
Echo (for Apple 16K)
Flyswatter (for Apple 16K)
Fool's Spool (for Apple 16K)
Football (for Apple 16K)
Football Predictions (for Apple
16K)
Galactic Battle (for Apple 16K)
Gunfight (for Apple 16K)
Jump Out/Shooting Stars (for
Apple 16K)
King (for Apple 16K,
APPLESOFT II)
Laser Turret (for Apple 16K)
Leap Frog (for Apple 16K)
Lunar Lander (for Apple 16K)
Magic Squares (for Apple 16K)
Match-Wits (for Apple 16K)
Mouse Hole (for Apple 16K)
Phasor Zap (for Apple 16K,
Assembly)
Pirates (for Apple 16K)
Quarterhorse Race (for Apple
16K)
Retreat (for Apple 16K)

Speedway (for Apple 16K, Assembly)
Star Dodger (for Apple 16K)
Super Dungeon (for Apple 48K)
Stratolaser (for Apple 16K)
Sub Command (for Apple 16K)
Sub Detect (for Apple 8K)
Sub View (for Apple 16K)
Super Othello (for Apple 16K)
Super Star Wars (for Apple 24K)
UFO (for Apple 16K)
Wipe Off (for Apple 16K)
(*Softape*)
Apple "21" (for Apple 24K)
Bomber (for Apple 16K, Assembly)
Craps (for Apple 24K, Assembly)
Forte (for Apple 16K)
Jupiter Express (for Apple 16K)
Microgammon (for Apple 16K)
Pro Golf (for Apple 16K)
Space Maze/Star Wars (for Apple 16K)
(*Apple Computer*)
Apple Startrek/Starwars (for Apple 16K)
(*Rainbow Computing*)
Adventure (for Apple 48K, APPLESOFT II, ROM)
Appleodion (for Apple 16K)
Devil's Dungeon (for Apple 16K)
Mountain Climber/Kronos (for Apple 16K)
Pacifica (for Apple 16K)
Rainbow's Casino (for Apple 16K)
Rainbow's Pot O' Gold (for Apple 16K)
Space War (for Apple 16K and 24K)
Pot O' Gold II (for Apple 16K)
(*Software Factory*)
Bam-Beneath Apple Manor (for Apple 16K and 32K, BASIC, Assembly)
(*Personal Software*)
Bridge Challenger (for Apple 16K, Assembly)
Microchess (for Apple 16K, Assembly)
Stimulating Simulations (for Apple 16K)
(*Quality Software*)
Fastgammon (for Apple 16K, Assembly)
(*Hayden Book Co.*)
Game Playing with BASIC #1 (for Apple 16K)
Game Playing with BASIC #2 (for Apple 16K)
Game Playing with BASIC #3 (for Apple 16K, Applesoft II)
Sargon (for Apple 24K, Assembly, TRS-80)
(*Edu-Ware*)
Rescue/War (for Apple 32K and 48K, APPLESOFT II)
Space (for Apple 48K, APPLESOFT II, ROM)
Story Teller (for Apple 32K, APPLESOFT)
Zintar/Prophet (for Apple 48K, APPLESOFT II)

CATEGORY: LANGUAGE

(*Microproducts*)
Assembler/Disassembler (for Apple 48K)
Microproducts Assembler (for Apple 16K)
(*Apple Computer*)
APPLESOFT II (for Apple 16K)
(*Programma International*)
ASM65 Assembler (for Apple 48K)
FORTH (for Apple 32K, Assembly)
Lisa Assembler (for Apple 48K)
Tiny PASCAL (for Apple 16K) (32K recommended)
(*Softape*)
FORTH II (for Apple 24K)
Level III BASIC (GRT/G2) (for TRS-80 16K, Level II BASIC)

CATEGORY: PERSONAL OR HOME INFORMATION

(*Programma International*)
Analyst (for Apple 48K)
Biorhythm (Apple 16K)
I Ching (for Apple 32K, APPLESOFT II)
Tarot Cards (for Apple 24K)
Hi-Res Character Generator (for Apple 16K)
Power Editor (for Apple 16K, Assembly)
(*Rainbow Computing*)
Filemaster (for Apple 32K)
Memory Verify (for Apple 16K, Assembly)
(*Apple Computer*)
Datamover/Telepong (for Apple 16K)
(*Softape*)
Screen Machine (for Apple 24K)
(*Edu-Ware*)
Shape Scaler (for Apple 32K, APPLESOFT II)
(*Computer Headware*)
Whatsit (for Apple 32K and 48K)

CATEGORY: PERSONAL-FINANCIAL

(*Apple Computer*)
Dow Jones Portfolio Evaluator (for Apple 32K, Integer BASIC, APPLESOFT, Assembly)
Apartment Building Investment Analysis (for Apple 16K, APPLESOFT)
(*Programma International*)
Realty Package (for Apple 48K, APPLESOFT II, TRS-80, Level II BASIC)

CATEGORY: TEXT EDITORS

(*Programma International*)
Formatter (for Apple 48K, Assembly)
(*Muse*)
Dr. Memory (for Apple 32K, Assembly)

CATEGORY: MISCELLANEOUS

(*Powersoft*)
Function Graphs and Transformations (for Apple 32K, APPLESOFT)
(*Truax*)
Omni Plotter (for Apple 48K, APPLESOFT)
(*Muse*)
U-Draw (for Apple 16K)

Softape
10432 Burbank Boulevard
North Hollywood, CA 91601

CATEGORY: TOOLS

Apple-Lis'ner
Appletalker
Electronic Card File
Forte
Screen Machine

CATEGORY: ENTERTAINMENT

Apple "21"
Best of Bishop
Bomber
Coney Island
Crazy 8s
Craps
Fighter Pilot
Go-moku
Instant Library Cassette
Instant Library Disk
Journey
Jupiter Express
Microgammon
Music Kaleidoscope
Pro Golf 1
Racer
Rocket Pilot
Roulette
Solitaire Poker
Star Wars
Talking Calculator
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17 Briarcliff Drive
Milford, NH 03065

CATEGORY: GAMES

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Chess Companion (Level II, 16K)
Microchess 1.5 (Level I or II, 4K)
Three-D Tic Tac Toe (Level I or II, 16K)
Concentration (Level I or II, 16K)
Amazin' Mazes (Level II, 16K)
Time Bomb (Level I or II, 16K)
George Blank (Level II, 16K)
Snake Eggs (Level II, 16K)
Life Two (Level II, 16K)
Android Nim (Level II, 16K)
Cubes (Level II, 16K)
Mastermind II (Level I or II, 4K)
Robot Plus Breakaway (Level II, 4K)
Tycoon (Level II, 16K)
Star Trek 111.3 (Level II, 16K)
Ten Pin (Level II, 16K)
End Zone (Level I or II, 16K)
Transatlantic Balloon Voyage (Level II, 16K)
Kamikaze (Level II, 16K)
Safari (Level II, 16K)
Taipan (Level II, 16K)
X-Wing II (Level II, 16K)
Space Battles (Level II, 16K tape or 32K disk)
Air Raid (Level I or II, 4K)
All Star Baseball (Level II, 16K)
Round the Horn (Level II, 16K)
Pork Barrel (Level II, 16K)
Slalom (Level II, 16K)
Pentominoes (Level II, 16K)
Mean Checkers Machine (Level II, 16K or disk)
Treasure Dungeon II (Level II, 16K)
Adventures (Level II, 16K)
Dogstar (Level II, 16K)
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Journey to the Center of the Earth (Level II, 16K)

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Personal Finance (Level II, 16K)
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CATEGORY: PERSONAL

Typing Tutor (Level II, 16K)
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Keyboard 80—Improved (Level II, 16K)
Secrets of the Tarot (Level I or II, 16K)

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Text-80 (disk, 32K)
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Math Drill (Level II, 16K)
Drill Masters (Level II, 16K)
Calculator (Level I or II, 4K)
Preflight (Level II, 16K)
Ham Radio (Level II, 16K)
Basic Statistics (Level II, 16K)
Moving Signboard (Level I or II, 4K)

CATEGORY: BUSINESS

Mail List II (for 32K disk)
Small Business Bookkeeping (Level I or II, 4K)
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Payroll (for 32K disk)
General Ledger I (for 32K disk)
Accounts Receivable (for 32K disk)
Inventory 2.2 (for 16K disk)
Inventory Modular (Level I or II, 16K)
Inventory System 2.3 (Level II, 16K)
Inventory "S" (Level II, 16K, 32K disk)
Appointment Log (Level II, 16K)

CATEGORY: COMPUTER LANGUAGES

TRS-80 FORTRAN
Level III BASIC
MMSFORTH (Management System in FORTH language)

GLOSSARY

Accumulator A register that receives, totals, and holds information, in the form of bits, for arithmetic and logic operations

Address Spot in CPU memory identified with specific number

Address register Exact location in memory where an address is held

Algorithm A set of standard procedures or rules for solving a problem

Alphanumeric Description of letters (alphabet), numbers (numeric), and punctuation marks used in computer languages

ALU Acronym for "arithmetic logic unit." The area of the microcomputer that adds, subtracts, shifts numbers, and so on

Antiope The name of the French Videotext (or Teletext) system tested in experiments in the United States in 1979 and 1980

APL Acronym for "A Programming Language"

Applications program A program written to carry out a specific job, usually in a high-level language such as BASIC

Architecture The physical structure of a microcomputer's internal operations, including memory, registers, ALU, and so on

Assembler Software that changes an assembly language program into machine language. It translates symbols, such as English letters, into binary digits.

Assembly language A program language, similar to English, that breaks BASIC down into digital codes. This language is halfway between a programming language and the internal binary language of machine operation (machine language).

ASCII Acronym for "American Standard Code for Information Interchange." It gives a unique seven-bit code for each letter, number, symbol, and punctuation mark to create compatibility among different computer systems and languages. It has 128 codes in its basic form.

BASIC Acronym for "Basic All-Purpose Symbolic Instruction Code." An easily learned, English-like programming language developed at Dartmouth College. The most popular language for home computers

Baud A measurement of the rate of data transmission. One baud equals one bit. *Baud rate* stands for bits transmitted per second.

Binary The Base-2 number system in which the only numbers are 1 and 0

Bit Binary digit. Each bit represents one character in a binary number: The number 2 equals 10 in binary and represents 2 bits.

Block A group of characters, letters, numbers, or symbols received, recorded, or stored as one unit. See *Packet*

Block diagram An easy-to-understand drawing that outlines the functions and relationships within a computer system or computer devices

BPS Bits per second

Bug A mistake or problem in a program or hardware

Bus A circuit or group of circuits which provide a path between a microprocessor and any other part of a computer. The three types of buses are data, address, and control, each of which moves digital signals and information in the form of bits.

Byte Group of eight bits handled as one unit

CAI Acronym for "Computer-Assisted Instruction"

Carry As in arithmetic, when two numbers added together exceed the value of a register, the total is brought forward into a new register. For example, in regular arithmetic, 9 + 1 equals 10, with the 1 carried to a new column; in computer digital arithmetic, 1 + 1 equals 10.

Cassette interface The physical circuit that connects a cassette tape recorder and a home computer

Cathode ray tube A video tube somewhat like a television that is used to show "output," or letters and numbers, on its screen. Abbreviated to CRT

CEEFAX The British Post Office's name for its Teletext system

Character Letters, numbers, symbols, and punctuation, each of which has a specific meaning

Chip Common term for an integrated circuit etched on a tiny piece of silicon or germanium

Circuit A path or group of conductors that provide electrical communications among computer devices

Clock An internal timekeeper that assures computer operations occur in order

COBOL Acronym for "Common Business-Oriented Language." A high-level programming language designed primarily for business applications and large computers

Compatibility The ability of different computers or peripherals to work together without extraordinary physical connections

Compiler A program that translates a high-level language into a machine language

Computer language Any group of letters, numbers, symbols, and punctuation marks that enable a user to instruct or communicate with a computer

Courseware Name for computer programs used in teaching applications

CPS Characters per second

CPU Central Processing Unit

CRT See *Cathode ray tube*

Cursor Dot on a video screen that indicates where the next character will be shown; also used to indicate move or search operations on the screen

Cybernetics The study of artificial intelligence

Data Another name for any kind of information that a computer processes

Data base An organized collection of information

DBMS Acronym for "Data Base Management System," a complete collection of computer programs that organizes and processes a particular data base

Debug To eliminate mistakes from a program. See *Bug*

Dedicated A computer structured or programmed for one specific purpose

Disk drive See *Floppy disk drive*

Diskette A 5¼-inch floppy disk. Also called a minifloppy disk

Documentation The precise written description and listing of a program and supporting information to help users operate programs more efficiently

DOS Acronym for "disk operating system," the set of programs that controls a floppy disk drive

Dump Popular term for sending data from a computer to a mass storage device

Editor A program that lets a user correct, change, or manipulate text within a computer system; usually shown on a video screen. Also called a text editor

EIES Acronym for "Electronic Information Exchange System." An experimental computer conferencing network begun at the New Jersey Institute of Technology

Error message The message a computer produces when a user has made a mistake in an entry or in computer "grammar"

Execute A command that tells a computer to carry out a user's instructions or program

Facsimile An exact reproduction of printed material. In modern communications, computers are used to transmit facsimile copies across large communications networks.

Fetch An instruction to call up an instruction or information from a computer's memory

File A group of records or information that the user considers a unit, such as an accounts receivable file

Firmware Programs fixed in a computer's ROM (Read Only Memory); as compared to software, programs held outside a computer

Fixed memory See *ROM*

Floppy disk drive A flexible, soft plastic disk used for mass storage of information and the physical device that operates or drives the connection between the computer and the disk

Flowchart A simple outline that helps a user develop a program with standard symbols and logical functions

FORTRAN Acronym for "Formula Translator." An early computer language primarily for scientific and mathematical applications

Glitch Popular term for an electrical or hardware problem

Hard copy Printed information produced from a computer for permanent storage; term coined by computer pioneer Ted Nelson

Hardware Common term for the physical structure of any home computer or peripheral devices

High-level language Any English-like language, such as BASIC, that provides ease of use for untrained programmers and generates machine language with functional statements

IC Acronym for "integrated circuit," a tiny silicon or germanium slice that holds thousands of transis-

tors, capacitors, and other electronic components

Information providers A term for the large companies that supply information to a computer network, such as MicroNET, for a fee

Input Any kind of information that one enters into a computer

Input device Any machine, such as a keyboard, that enters information into a computer

Instruction A group of bits that determines a computer operation

Integrated circuit See *IC*

Integrated video terminal A home computer that combines a computer, telephone modem, videocassette recorder, printer, and other devices into one modern communications/information appliance

Intelligent terminal A terminal that has its own microcomputer and performs many functions on its own, saving the time of the central computer

Interactive Also known as "conversational mode"; refers to the "conversation" or communication between a computer and a person.

Interface Any hardware/software system that links a microcomputer and any other device

Interpreter A program that translates and carries out a high-level language such as BASIC; most home computers require a BASIC interpreter either in ROM or RAM to operate.

I/O Acronym or "input/output" Input means to enter information into a computer. Output is the information a computer transmits after processing input.

I/O port A connection between a microcomputer's CPU and any external devices, including video monitors and peripherals

IVT See *Integrated video terminal*

Joystick An instrument, usually a level, sometimes a knob or rotating, disk, with which to play video or computer games

K, kilo Represents 1,000 in normal counting; stands for 1,024 bits or bytes in computer operations: 4K equals 4,096; 8K, 8,192

Keyboard Instrument that resembles a typewriter, used to communicate with the computer by entering keystrokes

Large-scale integration See *LSI*

LCD Acronym for "liquid crystal display." A way to make letters and numbers appear by reflecting light on a special crystalline substance. Most often used today in watches, calculators, and hand-held electronic games. Companies are experimenting with LCDs for home computers.

LED Acronym for "light-emitting diode." An electronically formed light that displays numbers and letters on a screen

Library A collection of programs that serve one general purpose

Line printer A device that prints hard copy at very high speeds

Logic The way in which a home computer switches On-Off bits; the study of making the computer operate with logic functions

Loop A series of computer instructions that may repeat themselves for a certain number of repetitions

Low-level language Machine language or code. See *Assembly language*

LSI Acronym for "large-scale integration." The method by which at least 1,000 or more circuits are etched onto an integrated circuit or chip.

Machine language The binary code or language in which every bit of every step or instruction has a fixed or specified value; also, the language that a computer can directly "understand"

Magnetic disk A soft or hard round plastic disk on which computers store bits

Mainframe 1) The physical structure that holds the CPU of a microcomputer; 2) a large computer used by business and government for very complex computing tasks.

Mass storage A place in which large amounts of digital information are stored, such as a cassette tape or floppy disk

Memory The location in a microcomputer that stores information and instructions. Each piece of information or instruction has a unique location assigned to it within a memory.

Memory capacity Amount of available storage space, in Kbytes

Menu A list of options within a program that allows one to choose which part one wants to interact with. On a disk, a menu may offer a choice of programs. Menus allow users to easily and quickly get into programs without knowing any technical methods.

Microcomputer An entire system with a microprocessor as its central processing unit, memory, and input/output controllers

Micro-floppy disk A new type of soft disk memory, about three inches in diameter.

Microprocessor The "intelligent" part of a microcomputer which holds a complete arithmetic logic unit and important registers on a single chip of sil-

icon and controls all of the functions and calculations within a home computer.

Mini-floppy disk A 5¼-inch soft, plastic disk used to store information in digital form. See *Floppy disk*

Modem Acronym for "modulator-demodulator." An instrument that lets a home computer communicate with another computer over the telephone lines or other networks

Monitor Internal program that acts as "traffic cop" for computer operations. See *Firmware*

MOS Acronym for "metallic oxide semiconductor." The most common type of material and structure used to make integrated circuits

Motherboard Also called "breadboard" or just "board." A plastic plate that provide space and female connections for the CPU, I/O circuits, buses, memory, and peripheral control chips

MPU See *Microprocessor*

Network An interconnected group of computers or terminals linked together for specific communications

Nibble Popular term for a four-bit group of bits; half a byte

OCR Optical Character Recognition

Operating system A collection of programs that helps a home computer user control a computer's operations. Abbreviated to OS

Oracle The British name for a Teletext system operated by its Independent Television Network

OS See *Operating system*

Output The data or information a computer displays, prints or transmits after it processes input. See *Input* and *I/O*

Packet switching In data communications networks, the process through which groups of bits are sent in bursts in between other digital signals

Parallel Refers to a computer's performing operations all at the same time, rather than in series

PASCAL An advanced, high-level programming language

Peripherals Any external input or output device that communicates with a home computer, such as disk drives, light pens, printers, and so on

Plotter A peripheral, such as the Apple Graphics Tablet, which uses an electronic stylus or pen to draw charts, graphs, histograms, and other designs in printed form.

Port A physical I/O connection, linking a microprocessor to any other device or circuit; usually, ports have one-byte channels.

Printer See *Line printer*

Program A set or collection of instructions that causes a home computer to carry out or execute a given operation. See *Software*

Programming The process of writing a program

PROM Acronym for "Programmable Read Only Memory"

QUBE The name of the Warner Cable Company's test of an interactive Viewdata-type service in Columbus, Ohio, and Texas

RAM Acronym for "random access memory." Any memory into which you can "read" or call up data, or "write" or enter information or instructions. Any memory in which a computerist can gain direct access to any memory location at any time. RAM loses its programs or instructions and information when the power is removed.

Record Similar to *File* (which see)

Register A circuit that holds or stores bits in a CPU

ROM Acronym for "read only memory." Any memory in which information or instructions have been permanently fixed. ROM cannot be changed except under highly unusual conditions.

S-100 bus A common bidirectional bus. It approaches an industry standard.

Scratch-pad memory RAM that holds information or instructions temporarily

Semiconductor Material, usually germanium or silicon, that allows a better flow of electricity than an insulator, but not quite as good as a conductor. Depending on temperatures and pressures, a semiconductor can control a flow of electricity. It is also the material from which integrated circuits are manufactured.

Serial One-by-one information or instruction fetching or execution; as opposed to simultaneous parallel fetching. See *Parallel.*

Simulation The creation of a mathematical model, using computers, that reflects a realistic system

Soft copy Letters, numbers, symbols, words, and so on shown on a video screen without being in a "hard" or printed form

Software 1) A set of programs for one type or group of specific purposes; 2) any programs used to operate a home computer

Solid-state Electronic components made of solid materials, such as semiconductors, that conduct electricity

Storage The process or location for holding information or instructions inside a memory

String A list of words or statements in a computer program

Syntax Set of rules dictating the "grammar" of a home computer language

Teleprocessing Carrying out computer operations with long-distance communications networks

Teletext Generic name for a television system that flashes printed text on a TV screen while the regular broadcast continues; the system takes advantage of an unused portion or "blank space" in the TV video signal.

Terminal Any instrument that allows a person to communicate with a computer: a video display, a keyboard, or a Teletype

Terminal emulator A software system that enables a home computer to act like a terminal and communicate with other computers

Text editor See *Editor*

Time-sharing The computer's capability of running more than one terminal at a time

Utility program Software that executes tasks that are often required

VCR Acronym for "Videocassette Recorder"

Video display A device that shows computer ouptut on a televisionlike screen. Also called "video screen" or "video monitor"

Viewdata An interactive information network that works through the telephone lines, but displays its input and output on a television screen

Wafer The thin round piece of silicon from which integrated circuits are made.

Word A basic group of bits that are processed together. Home computers most often use eight- or 16-bit words.

Word length Also called "word size." The length of a rational grouping of bits. A byte has a word length of eight bits.

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Robert L. Perry has written numerous articles for *Popular Mechanics* and other magazines on home computers. He is also the consulting editor and sole author for the first *Mechanix Illustrated Guide to Personal Computers*. Mr. Perry writes frequently on business and financial topics for a number of publications and lives in New York City.

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