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PUBLICATION

your OWN COMPUTER

by Mitchell Waite
and
Michael Pardee



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by

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&

Michael Pardee

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Preface

According to authorities, scientists, engineers, and businesspeople, a technical revolution with an impact even greater than that of the automobile, transistor, and television combined is about to be unleashed on the world. The "personal computer," discussed for decades as a science-fiction novelty, is suddenly becoming a real consumer product and promises to change the very fabric of our daily lives. Based on tiny "microcomputers" which cost less than a dollar, the personal computer will soon become the central regulator of energy in our homes, will monitor our spending habits, and will provide our children with an education we could never afford to furnish them.

Today few people realize that a computer for the home can be purchased for about the same price as a good stereo system. Retail stores are already making plans to sell you "your own computer" and advertising campaigns will soon herald the home computer as the consumer product of the future. In order to understand and appreciate the fantastic value of this new product, consumers will need to become familiar with what these inventions can—and can't—do. The purpose of this book is to introduce the novice to the new home computers and to reveal in the simplest possible terms the incredible potential of these technical marvels. Because of the stigma of complexity and mystery that surrounds the computer, it is hoped that in these pages you will find that, in fact, computers are simple, easy to understand, and, most of all, extremely helpful devices.

This book has been especially designed to be your first investment in the personal computer field. The text starts out by explaining just what personal computers are, how these fantastic inventions evolved, and where they are headed. Chapter 2 discusses what home computers are capable of doing, and how they are being used by people today to make life easier and more fun. In Chapter 3 the subject of programming is covered, and the reader is given a simple introduction to the personal computer language called BASIC. Chapter 4 discusses the "nuts and bolts" of computers—the various hardware elements you may encounter when purchasing a personal computer for your home or business. In the last chapter we explain how one goes about getting started in this growing field, and how to begin your education so you can make intelligent consumer decisions.

In all the chapters very little is assumed about the reader's knowledge of computers. Appendix A contains a generous personal computer glossary which will provide you with all the "buzz words" of computers today. There is also a list of computer abbreviations in Appendix B which will help you understand some of the new computing terms appearing in advertisements and texts.

Given the fantastic problems facing our society today, from energy regulation to food consumption, it may be that the home computer with its potential for instant information and mass education, will be the neutralizing element that stabilizes our planet and brings peace to a changing world.

The authors, therefore, hope that this book will provide the beginner with enough knowledge and confidence to utilize this fantastic invention and to pursue this most interesting subject.

MITCHELL WAITE
MICHAEL PARDEE

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chapter 1

Introduction

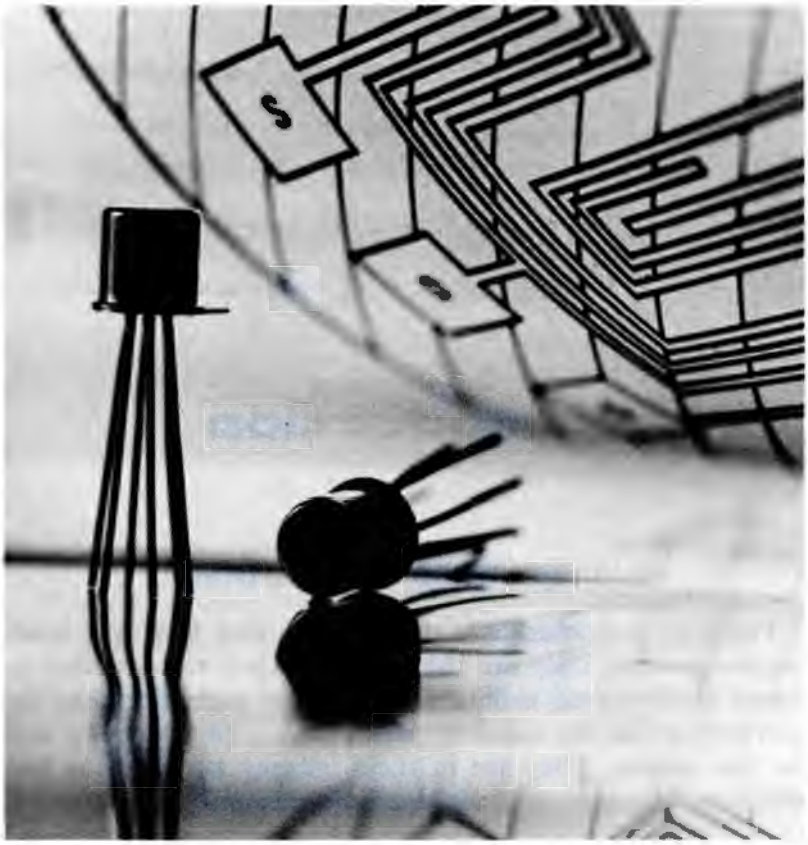
WHAT ARE PERSONAL COMPUTERS?

Personal computers are small computers that are inexpensive to own. They are the result of many recent developments in electronic technology. Personal computers can do everything that big computers can do, but in less space and for less money. They are in their infancy at this time but will soon become a common appliance around the home.

WHERE DID THEY COME FROM?

Several years ago, the development of the transistor made possible many modern conveniences. The first product to become popular was the transistor radio, which was often nicknamed the "transistor." A few years later, transistors began appearing in all types of consumer products. Some television manufacturers were employing transistors in their sets to prolong the lives of their products. Stereo systems were also being manufactured using this new marvel of technology. Soon, every electronic device that once used vacuum tubes had been redesigned to utilize the transistor.

It was only natural that computers also would be converted to transistorized versions, since the early models which used vacuum tubes were very large and expensive.



Courtesy National Semiconductor Corp.

The infamous transistor.

By the late 1950s almost all contemporary computers were using transistors. This phenomenon became known as "second generation" computers, since they had evolved from the old tube-style models.

It was during this time that the "space race" was in full swing. The United States was in competition with the Soviet Union to be the first country to successfully launch an artificial satellite. This would inevitably lead to putting a man into space and finally on the moon. Since the "space-going" electronics had to be small and lightweight, the transistor was perfected to a fine state. The research that went into this perfection provided the groundwork for the mass pro-

duction of "solid-state" electronic circuits. These new devices were called "integrated circuits" (ICs) because they were entire electronic circuits fabricated into a single package. Like the transistor, the IC was manufactured from semiconductor material but in such a way that not one, but many transistors could be produced on one tiny "chip." The implications of such a development are shocking! Electronic devices which once required many discrete parts could be built using only a few ICs. As the manufacturing expertise has improved, the "unit cost" of such IC devices continues to drop. In the early 1970s the first evidence of this technological revolution became known to the public in the form of the electronic calculator.



Courtesy NASA

The space race.

The first calculators were the direct result of the ability to design electronic devices using integrated circuits. The thousands of transistors necessary to make an electronic calculator work could now be contained within just a few IC chips. Although the first calculators were rather expensive

($300–$500), they were very low priced by comparison to what they would have cost just a few short years before. As the consumer market began to realize the value of owning an electronic calculator, the demand for them increased. This guarantee of a market for large numbers of calculators spurred the manufacturers on to develop even less expen-

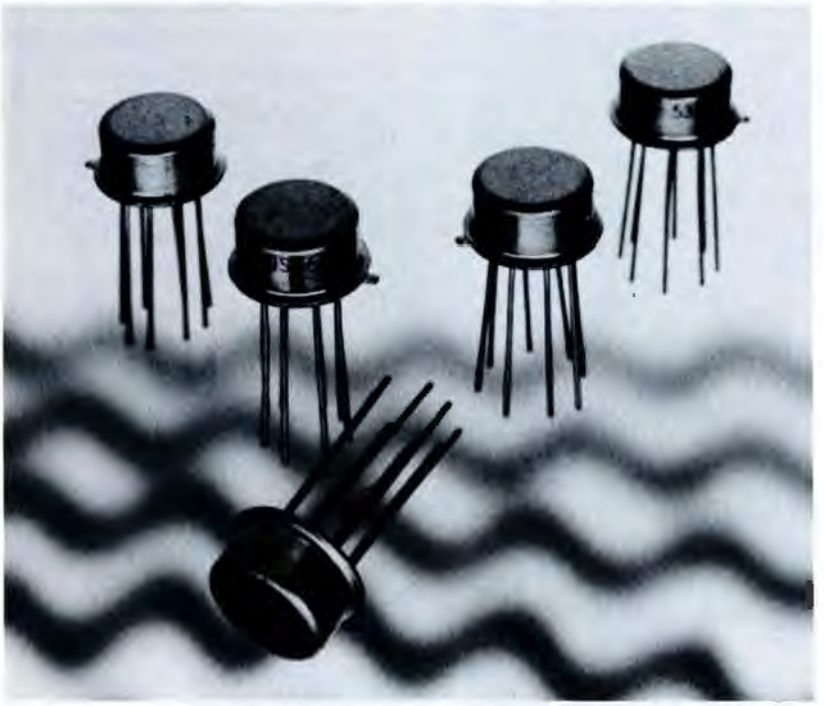


Courtesy NASA

The race won—man on the moon.

sive production techniques. In the space of about two years, the prices of calculators were cut in half. Two years later they were cut in half again, bringing them within the economic reach of just about everyone. Lower and lower the prices dropped until today a simple model can be purchased for under ten dollars.

The reason for this continual drop in the prices for electronic goods (calculators included) was the further advances in the "state-of-the-art" of solid-state electronic technology. The manufacturers were finding it possible to integrate more and more parts inside a single package. Some of the more recent calculators have been made using



Courtesy National Semiconductor Corp.

The integrated circuit (IC).

one or two large ICs which contain all of the electronic circuits that make the calculator work. This trend eventually lead to a manufacturing technique known as "large scale integration" (LSI). It was again inevitable that these new devices would be incorporated into computers. Since computers consist of many similar circuits they can be fabricated into one small package that functions exactly the same as when separate circuits are used, but is much less costly.

The most significant event that occurred only recently was the advent of the tv or video game. First located in bars, amusement parks, and shopping centers, these most often took the form of a sort of tennis game being played



Courtesy Hewlett-Packard

The pocket calculator.

with a small white dot that moved across the screen like a ball. The players operated their paddles by using simple potentiometers or joysticks. In between the potentiometers and the screen were a mass of computer-like electronic cir-

cuits that made the whole thing work. Some models even kept score and displayed the numerals on the screen. Again the trend toward denser circuit integration prevailed, and shortly there were tv games on the market that used only one LSI chip. This naturally brought the prices of tv games down to an amount affordable by many people and the home tv game became a popular item.

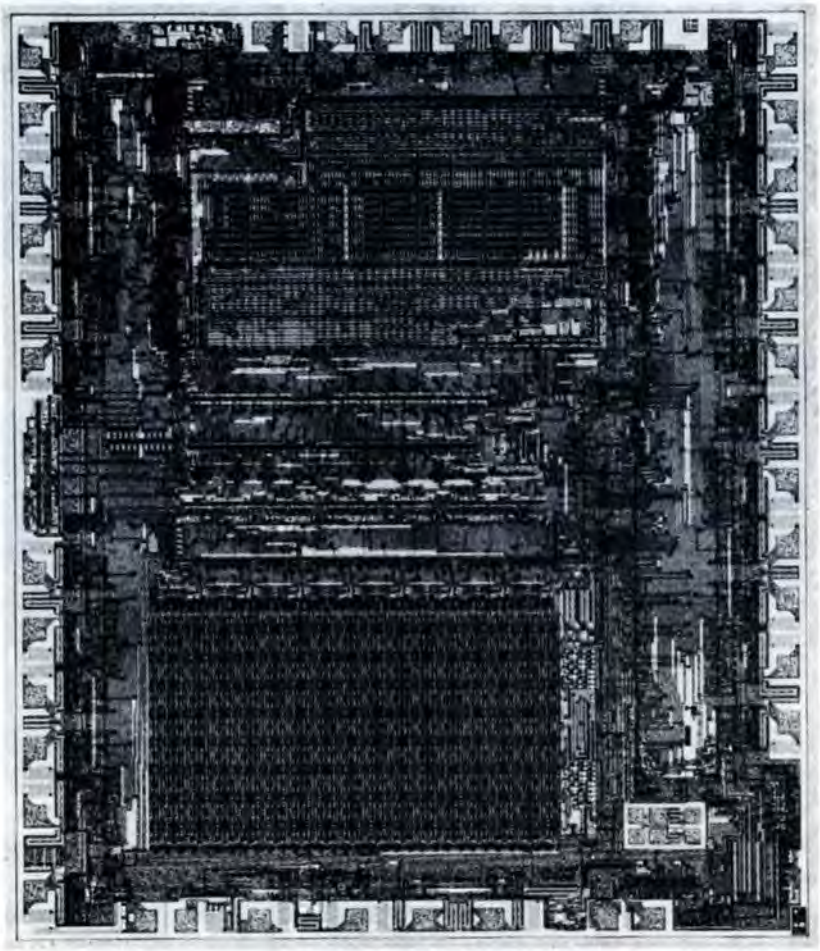


Courtesy National Semiconductor Corp.

Large scale integration.

By the late 1970s, new products were being announced almost every day which were based upon some recent advancement in the state-of-the-art electronics. The once-simple electronic calculator is now capable of performing sophisticated mathematical functions. Some calculators are even programmable by the user to do whatever combination of operations might be needed. We see new wristwatches that no longer have a face and hands but instead have glowing red numerals that blink on when the owner's arm is

moved. Many modern supermarkets are exchanging their old cash registers for the new electronic versions which do a number of automatic operations while the grocery bill is being tallied. Microwave ovens have built-in memories that can be programmed to turn the oven on at a certain time and cook at a certain temperature for a prescribed length of time. But the most dramatic sign of what this new technology will mean for society is the development and evolution of the personal computer.



Courtesy Fairchild

The LSI chip.



Courtesy Fairchild

The tv game.

Digital watch.



Courtesy Novus

WHERE ARE THEY GOING?

Actually, single-chip computers have been around since the early 1970s, but these early computers were being used by industry to perform complicated manufacturing processes. It was not long before a "microcomputer" was marketed for the hobbyist. Since there was not a real demand for personal computers, and since the expected market was small, the first of these devices were available only as kits. With a few hours of soldering one could be the first on the block to be the owner of a computer, complete with rows of switches and blinking lights. This idea caught on quickly, and across the country and around the world groups of microcomputer enthusiasts formed to exchange ideas and to help each other get started in this fantastic new hobby.



Courtesy Apple Computer Co.

Portable personal computer.



Courtesy Noval, Inc.

Desk model personal computer.

At the sight of this promising new market, the manufacturers began to enhance their products by adding various attachments and offering programs to do some simple jobs. Many of the problems associated with microcomputers have been ironed out, and in general, the quality of the products has improved significantly. Likewise, as the market grows, the prices will drop further due to the economy of high-volume manufacturing. Stores that sell personal computers are beginning to open across the country. Giant department stores are selling home computers next to calculators, and more and more people are getting involved at a variety of levels. Some people are buying completely assembled and preprogrammed home computers. Others are having a friend build one for them. With so many ways to acquire a personal computer it won't be long before everyone owns one. The big question then will be "what can you do with it?" In the next chapter we will explore this question in more detail.

chapter 2

Personal Computer Applications

IN YOUR HOME

The home is where your personal computer will most likely be born. If you decide to build it yourself, it will undoubtedly be "fired up" in your workshop and tested for a while before you begin to put it to work. If you buy it preassembled you will want to begin using the various programs that come with it. Once you have determined that everything seems to be working correctly, you can plan on setting up some kind of simple function to start. As you develop more skills with your personal computer, you can move on to bigger and better things.

The Home Accountant

There are many ways in which you can use a personal computer to aid you in financial matters. Accounting is a discipline which requires a precise approach to mathematics (something by which the computer comes naturally). For example, the monthly routine of balancing your checkbook. This is something which could not only be more accurate with a computer, but would also be more fun! To begin with, you would have to establish your current balance by

hand, and enter it into the computer. Then, each month (or other convenient interval) you would have to enter into your computer the following information:

1. The amounts of any deposits.
2. The amounts of all the checks you have written.
3. The amounts of any "bank entries."
4. The numbers of the canceled checks which you have received from the bank.

Then, faster than you can blink an eye, your personal computer will tell you your current balance.

This procedure could be done every day if desired, thereby giving you up-to-the-minute information regarding the state of your checking account. This kind of information is essential for good budget planning and expense control. You can easily determine your spending habits and even see how to save money.

Income Tax Filing

Income taxes are another area where your personal computer can save you a great deal of time, and maybe even some money. Whether you itemize your deductions or file the short form, your home computer can be like having your



The home accountant.

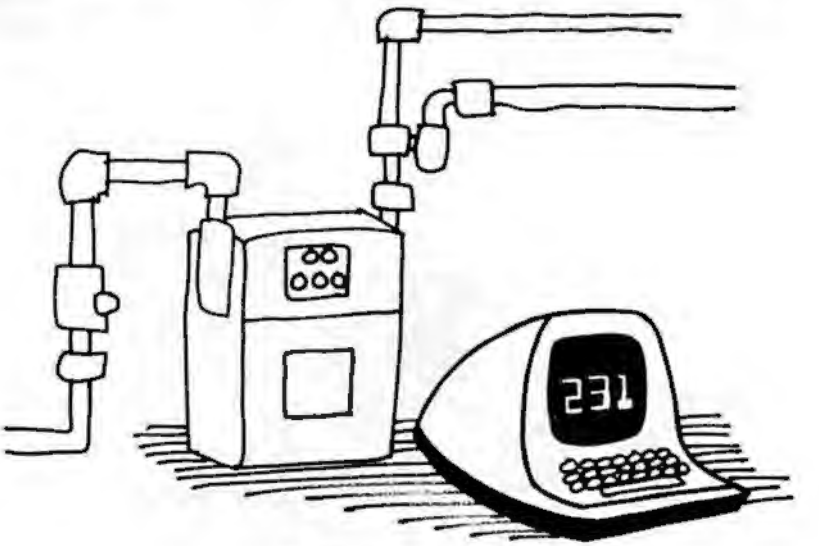
own personal accountant. The big problem with income tax preparation is that most people put it off until the last minute, and then have to wade through mountains of receipts and canceled checks to derive the various deductions. This procedure is something that your personal computer can do automatically during the entire year so that when the time comes, all you have to do is simply instruct the computer to produce an itemized listing of deductions. Once your taxable income has been computed, your personal computer can use its internal tax tables to figure your tax. It can even fill out your tax return forms for you so that all you have to do is sign them and drop them in the mail. In addition, your personal computer can save this information for as long as you want. Your home computer can also be used to estimate your income tax liability for the next year, so that there will not be any surprises regarding your taxes. In addition, saving all this information in your personal computer can provide for automatic calculation of depreciation of capital assets, as well as amortization schedules for any kind of loan payments and interest rates.

Management of Domestic Resources

Resource management is an area where the personal computer really shines. In an age when we see our world rapidly shrinking, and our necessary resources diminishing, we need to become more efficient in our use of such things as energy, water, food, and time. Your personal computer can be of great assistance in these areas. One thing that it can do with ease is to keep track of the food that you have on hand, and help you to plan meals more efficiently in order to eliminate waste. As certain items in the kitchen become depleted, the computer can provide you with a shopping list. About the only thing that your personal computer cannot do is wash the dishes . . . yet.

Besides being able to do all of the foregoing, your personal computer can also continuously monitor the use of other valuable resources around the home. It can be connected to the electrical system and automatically turn on or off any circuit you desire. It can even be used to randomly turn lights on and off in your home while you are away. In

fact, your personal computer makes an ideal central control point for a home intruder alarm system. And this is only the beginning. Once you have your own computer in your home, you will be thinking of all kinds of ways that it can be useful to you.



The home controller.

FOR FUN

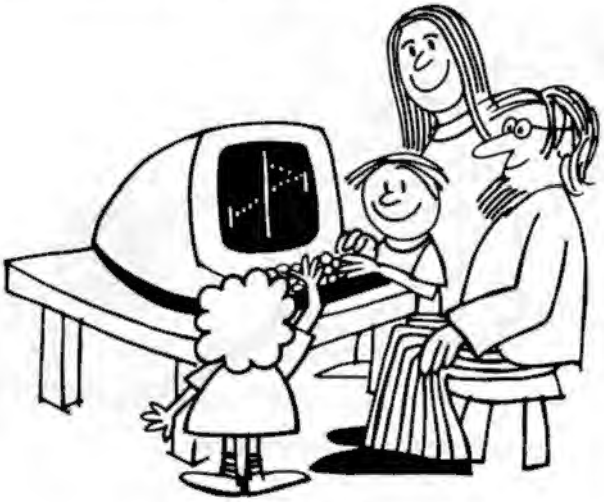
The fun aspect of having a personal computer is probably the greatest reason they have become so popular. They are fun to read about, talk about, look at, build, and work on. But aside from the inherent pleasures of the personal computer itself, there are many distinct pleasures that can be experienced while using the computer to help out.

Games with Computers

For plain fun and pleasure, personal computers mark the beginning of a new era in home entertainment. Personal computer games like Blackjack, Poker, Star-Trek, and Chess have special features that create intense family involvement. Imagine games that talk, calling each player by their first name. Game "boards" appear in full color on your

tv set. "Cards" can be shuffled and dealt. Even keeping score can be handled by your personal computer.

If you have children, a personal computer makes a unique, low-cost babysitter. There are literally thousands of computer games for kids of all ages. These are exciting, educational, and challenging games; the kind kids like the most. There are number guessing games, spelling word games, and games that teach general concepts. You can even create your own games for your children.



Playing games.

You have probably seen the new tv games offered by large department stores. These are "black boxes" you hook up to your tv, and are nothing more than microcomputers programmed by the manufacturer. With your own computer you can program anything you want, including games like the ones in the stores. When the entire family plays a game, you can have the computer save everyone's score. The computer can retain this information for as long as you wish, giving you the ability to see your skill grow. The best computer games allow the "intelligence" of the computer to be programmed-in. This means you can constantly improve yourself by gradually increasing the skill of your personal computer opponent.

Your Hobby and the Personal Computer

Another interesting facet of the personal computer is that it can usually be integrated into an existing hobby in such a way as to improve the enjoyment derived therefrom. If you are a collector for example (stamps, butterflies, coins, etc.), you can use it to keep track of your collection. When



Organizing your hobby.

you add to (or remove from) your collection, you can update the computer to reflect the change. Perhaps you are a photographer and have been meaning to get your photographs organized so that you can have quick access to certain ones. This is a perfect opportunity for your personal computer. One of the things that a computer does best is to keep records in a very organized manner. You can have the

computer sort information into any sequence that is meaningful to you.

If you belong to a club that is related to your interests, you will certainly find innumerable ways in which your personal computer would be of use. Most clubs have officers who are elected by the membership. Such an election could be conducted using a personal computer. The balloting could be done in secret, and the votes counted impartially by the computer.

Many clubs send out some sort of newsletter. This means that a list of all of the members in good standing must be kept up to date— an easy job for your club computer. As we have already mentioned, the computer is just great at keeping track of things. And, it can also shuffle things around by name, zip code, or whatever requirement is desired. If you connect your computer to a printer, or maybe to an old teletypewriter machine, you can program it to print mailing labels to speed up the task of sending out the club newsletter.

One other idea related to clubs concerns the organization of various duties and functions that are performed by the club on a regular basis. Things such as benefit luncheons or club-sponsored sports activities could include your club computer as an attraction. The more people that become interested in personal computers, the more interesting they will become. New ideas can be discussed, a sharing of information can take place, and the pleasures of your club will grow.

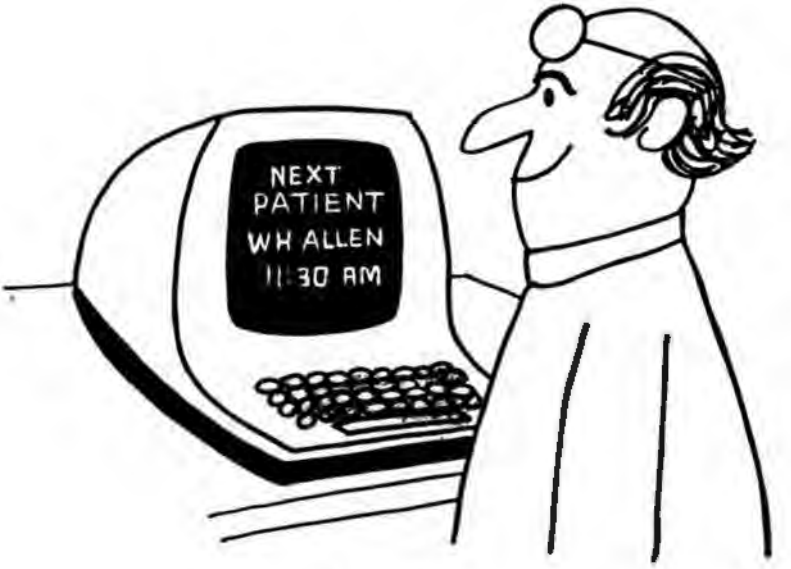
IN THE OFFICE

Monthly Statements

Perhaps the most practical and profitable use of a personal computer will be in your own small business. For example, instead of spending a whole day or more preparing monthly statements, you can just instruct your personal computer to do it for you. To accomplish this task you just use your computer to keep track of all work that you do for your customers, and also how much each of them pays you. Then, at the end of the month, the computer reports the

status of each of your accounts. Besides being able to do this important job for you, your personal computer can also provide you with timely reports pertaining to various aspects of your business. Perhaps the computer can keep track of your appointments throughout the day.

You and any employees whom you might have will be able to know the credit status of any given customer at any given time, as well as how good a customer he really is. If your business involves salesmen calling on your accounts to get business, you can use the computer to analyze their



In the office.

performance. If a product is part of your business, then inventory control is a big part of your business accounting that your personal computer can handle with ease. If you do not have a business now, perhaps your personal computer can be used to aid you in starting a business of your own.

Inexpensive Word Processing

If you have the need to maintain large files of data pertaining to your business, then the computer is an ideal man-

agement tool for you. You can use it to help compose letters and documents for your business that will look like they were done by a professional stenographer. If it happens to be a repetitive document such as a listing of items for sale, you can store it all inside your personal computer and quickly update it to reflect current conditions whenever it becomes necessary.

Many businesses require the use of certain forms of documents over and over. Legal forms especially seem to follow the same format although certain information might vary. Your personal computer can provide this kind of flexibility for your business, making it possible to assemble documents using standard formats and internally stored text. In general, anything that you now type or have printed as it goes out of date can be done faster, cheaper, and better with your personal computer.

Job Estimating and Cost Analysis

Knowing how much to charge a customer can often be difficult to determine. If there are many factors affecting the overall nature of the work to be done, the computer can be a real asset to the person in business. If you now spend a significant amount of your productive time just trying to develop a bid on a job, think of how much more profitable it would be to have your personal computer take care of it. The computer can easily keep track of all the minute details of determining the cost of a job, the ones you often overlook. You then spend more time with your customers, and getting the job done. Your customers will see you as a smart business person taking advantage of modern timesaving devices in order to do a better job for them.

When a job is finished, it is sometimes hard to tell if, in fact, it was profitable. How far off was your original estimate of your cost to do the job? Your personal computer can answer these and many other related questions. It can keep track of all the costs and the hours involved in doing a certain job; and upon completion it can give you the details in concise and accurate terms. You can then use this information to help you stay on a profitable track as your business grows. You now have immediate feedback on the results

of your business operations and can take corrective action in a timely and efficient manner.

IN THE CLASSROOM

Perhaps the most beneficial use of the personal computer is in education. Because it is versatile, impartial, and patient, the computer can be programmed to assist in the instruction of many different subjects. It can provide real-time interaction between the subject area and the student.



In the classroom.

For example, after discussion of a certain topic, the computer can ask the student several questions regarding the topic. The student enters his responses to the questions into the computer. Upon analyzing them, the computer will congratulate the student for correct understanding, or reinforce the topic with additional material.

If you are a teacher, and you have to spend many hours just keeping track of grades on quizzes, midterms, and final exams, you could probably make good use of a personal

computer. If confidentiality is important, you can program in a secret code so that only you are able to gain access to the information regarding your students.

The computer itself can be quite an educational experience for one who is not familiar with it. Due to its versatility, one of the greatest things it can do is just *be there for someone with an inquisitive mind to play with.* As the student begins to understand what the computer can do, a flood of new ideas will spring forth that might even teach the teacher a thing or two. In fact, unless you're careful, you just might find that you have to wait in line to use *your own computer.*

chapter 3

Programs for Your Computer

Today it is difficult to imagine an area of life that remains unaffected by the computer. The hundreds of parts in an automobile are made under control of a computer. The complexity of a television set or a stereo system is made possible by computer circuitry. The telephone, perhaps our most familiar electronic instrument, looks simple from the outside, but the total system that allows us to communicate is actually a formidable array of complex computer circuitry. The computer itself is not really that much more sophisticated than any of these other machines. But, there is one distinct difference that sets the computer apart from the rest—it is programmable.

COMPUTERS ARE PROGRAMMABLE

Because computers are programmable they can be made to act like *many* machines, rather than just one. For example, a toaster is a fixed function machine—it makes toast. It operates according to a rather simple "program," namely:

1. Plug the toaster in,
2. Put bread into the slot(s),

3. Select the desired "brownness,"
4. Push down the lever that activates the toaster.

The toaster does the rest. Now, there are a limited number of variations to this program (the toaster may even throw in one of its own and burn the bread), but, it cannot do anything besides make toast.

Even more sophisticated machines like the tv can only do one thing. They are called "fixed function" machines. The tv can only receive and display specially modulated radio-frequency signals. It cannot double as a toaster, or even as a stereo set. Your automobile, although very similar in many ways to an airplane, just will not fly. These cases are true because the "program" that governs the operation of these machines is not available for modification. The computer, on the other hand, is readily reprogrammable at any time. Its program can be completely replaced, or slightly changed in order to achieve some desired goal.



Courtesy Apple Computer Co.

Computers are programmable machines.

So, just what is a computer program? As we shall learn, there are several parts of a computer that make it what it is. The program is just one of these. There is a microprocessing unit (MPU), a memory, input/output devices, and the program. The program is simply a list of things that the computer has to do in order to complete some objective. In order for the computer to use this list, it must be put into the memory. This can be done in several ways, including typing it in through a keyboard. Once "loaded" into the memory, the program directs the operation of the computer. It is as if the computer is an electronic circuit that is continuously being rewired to make it perform slightly different operations each time.

This rewiring effect is caused by the fact that the actual program, once inside the computer, is reduced to a combination of different voltage levels. This is not, however, the way a human programs a computer. Voltage levels require knowing about power supplies and switching speeds and refresh times, etc. Rather than specifying voltage levels and rewiring plans, what we want to do is to tell the computer in straightforward terms what it is that we want it to do. Then, we can let the computer figure out the voltage levels for us. We can do this by using a *programming language.* There are several different programming languages in use today, offering a variety of ways to write programs. A programming language consists of several special words and phrases that direct the computer processing. In a sense they do the rewiring. These words and phrases are entered in the computer in the sequence they are to be performed.

These languages are most helpful if you really want to write programs. But what if you just want to use the computer to do a specific thing and don't want to become a programmer? This brings us to one of the first major decision points regarding your computer. Shall you write your own programs, or use ones someone else has already written?

WRITING YOUR OWN PROGRAMS

Many people get involved with personal computers because they are interested in computers themselves, and are

eager to write their own programs. But programming is a very exacting pastime. It requires that *all* things be considered by the programmer with regard to the particular job being done. There are many details that must be attended to so that the finished program will operate correctly. There is a great feeling of satisfaction upon completing a program and seeing it run for the very first time. In fact, programming can be a very creative activity. In programming a computer there are usually several ways to achieve the desired effects. If three programmers were assigned the same job to program, they would probably each do it in a different way. Although there are times when one way is definitely better than another, at other times it really doesn't matter. In order to understand what programming is about let's take a look at a typical program.

Our first example is a program written in BASIC. BASIC stands for *B*eginners' *A*ll-purpose *S*ymbolic *I*nstruction *C*ode. It is probably the most popular programming language used with personal computers. The particular example is a program which simply "reads" in two numbers (A and B), adds them together, calls the sum C, and prints the answer on the output device. We can see that this is accomplished quite readily with only three BASIC "statements."

```
INPUT A,B
LET C=A+B
PRINT C
```

First, to tell the computer to read in data from the keyboard, we use an INPUT statement. It specifies that two numbers are to be read when the user pushes the number keys, and that the numbers will be defined in the computer as "A" and "B." The arithmetic is performed by the LET statement, which is in the form of a simple equation. Finally, to print the answer "C" we only need to tell the computer to PRINT the value of C.

Let's enhance this program a bit and have it communicate with us in sentence form. Suppose we wanted the program to prompt us to enter the two numbers A and B, and also to make the computer print a little message at the end saying,

"The answer is C" (stating the value of C). The program would be modified as follows:

```
PRINT "ENTER A AND B"
INPUT A,B
LET C=A+B
PRINT "THE ANSWER IS", C
```

The computer will print out the words "enter A and B" so that we know when to enter them from the keyboard. In less than an eyeblink the computer calculates the answer and prints "the answer is" and the value of C right after it.

For the user very little work or thinking was required to complete this program. That is why BASIC is known as a "high-level language." It does much of the work for you. All that you have to do as the programmer is to enter the program statements in a logical and plain English format. Let's look at another example.

This time, we will program the computer in BASIC to read in five numbers and to print out the largest one. This kind of thing is often done by computers to sort different lists. To find the largest number we will use the ability of the computer to make decisions based upon the data. This is done by using the IF/THEN statement. The program looks like this:

```
PRINT "ENTER FIVE NUMBERS"
INPUT A,B,C,D,E
LET X = 0
IF A>X THEN LET X=A
IF B>X THEN LET X=B
IF C>X THEN LET X=C
IF D>X THEN LET X=D
IF E>X THEN LET X=E
PRINT "THE LARGEST NUMBER IS", X
```

So, to determine which of the five numbers entered is the largest we first start off by making up a test number (X) set to zero. Then, one by one, we compare the five numbers with X. Each time one is found to be greater than (>) X,

we replace X with that number. After comparing all five numbers in this way X will be equal to the largest of them all, and will be printed out.

There are many kinds of programs that can be "written" in BASIC language. Since BASIC is mathematically oriented, it is relatively easy to program mathematical operations with numbers and variables. Also, we have seen that in order to get the computer to print out a message, we just enclose the message in quotes within a PRINT statement. If you decide to write your own programs it will most likely be in BASIC, since most of the personal computers available today come with some form of BASIC.

If you really enjoy getting right down to the fundamentals of computer programming, then you will probably want to learn to program in the "assembly language" for your own particular computer. Assembly languages are much more *symbolic* than BASIC. Rather than instructing the computer in simple English and arithmetic statements, you must use mnemonic symbols that represent each machine instruction to be performed. This type of programming requires that the programmer be intimately familiar with the internal workings of the computer. In some cases, programming in assembly language will involve calculating the time (usually in microseconds) that it will take for each operation to be performed. Usually the programmer will have to deal with *hexadecimal* numbers. Assembly language is generally considered a *lower level* language because the programmer must leave the realm of plain English statements, and arithmetic equations, and enter into the inner logical workings of the computer itself.

Assembly language programs lend themselves well to such tasks as operating various peripherals connected to the computer. For example, in our sample BASIC program, we told the computer to PRINT several things, but there are many steps involved in getting a computer to print anything on a teletypewriter or printer. Since most of the printing devices used on personal computers print one character at a time, the computer must take care of transmitting the information to be printed, one character at a time. The program must also keep track of how many characters are to

be printed, and stop operating the printing device when the last character has been printed. All of these tasks are handled very well by assembly language programs, and the personal computer user who wishes to dabble in these kinds of operations will most assuredly have to become an assembly language programmer.

USING OTHER PROGRAMS

What if you don't have any knowledge of programming, and don't want to learn? Does that mean that you cannot get into personal computing? Absolutely not!

Throughout the world of commercial computing there are thousands of people using computers who do not know the first thing about what makes them tick. These people are termed "users" because they use a computer to allow them to complete some job they are working on. They are using a computer programmed by someone else. Generally, they have requested that the programming be done, and have overseen the development of the program to ensure that it would come out to do what they wanted. Then, they implement the program. If there appears to be some problem with the operation of the program, or if there is some change that they would like to make after using it for a while, they contact the programmer and request that a "fix" be made.

In many cases, the personal computer manufacturers themselves supply various programs (software) with the "hardware" they sell. These are programs that have been written by some programmer for the manufacturer. Since many people want to use computers for similar reasons, it is often possible to acquire "canned programs" for a common application. Sometimes it will be necessary to alter this canned program slightly to accommodate needs of a particular user. This can be done by the manufacturer, but is more often done by the user himself or by some person that the user recruits to change the program. Those who would rather not get involved with programming their personal computer can easily find someone to do it for them.

There are thousands of personal computer enthusiasts belonging to several hundred computer clubs across the

country. To save money, the user could contact one of these clubs and ask if there was anyone who might be interested in a little programming job. Without a doubt, there are many people who would jump at the chance to earn a little money helping a user.

The "nonprogramming user" should bear in mind that, for a given application, once a program is written and "debugged" it should require no further attention. It will work forever as long as the requirements remain the same, and the same computer is used. If it seems to be taking ages for a programmer to finish a particular job, perhaps the job is too difficult, or the programmer is not the best. Before entering into a deal, the personal computer user should get the programmer to commit himself to a specific price for the work, and the estimated time to complete the job. Also, you should arrange for check points at various intervals along the way to see if things are progressing on schedule.

A strange phenomena associated with computer programmers is that they always seem to be on the move. As new opportunities present themselves, the programmer will almost always shift his life around in order to take advantage of them. This could leave you, the user, high and dry. You might be left with a half-finished program that still requires some finishing touches. Well, you say, why not just take what you have, and find another programmer who can complete the job? This is easier said than done. Assuming that you could find a programmer who would want to take over someone else's work, it would take a long time for this new programmer to figure out what the original programmer was trying to do. As we discussed earlier, there are usually several ways to program the same task, and each programmer will have his own favorite approach. This brings up one very important point concerning *all* programming: All programs should be "documented." This means that there should be a description of what the program is intended to do, how it is supposed to do it, and any special considerations that must be taken in order for the program to work as planned. This is a must if you are planning to have someone else write your programs because the documentation

will allow someone else to take over with a minimum of problems, if necessary.

All and all computer programming remains a most interesting subject and will most likely be the center of attention in personal computing for many years. Today many programmers are of the opinion that the real cost of owning and using a computer will not be in the parts that make it up, but rather in the time and effort that goes into making a working program. It is therefore to your advantage to become as familiar as possible with the dynamics of getting a program for your computer that does what you want. It also makes sense to judge a computer not only on its inherent abilities, but also on just what programs the manufacturer has chosen to offer with the computer, how much they cost, and, most importantly, what the future plans of the company are in developing new programs. This way you will be sure of making the best possible decision in the personal computing field.

Not to be forgotten, however, is the importance of acquiring the proper devices for your computer to enable it to do what you want as quickly and painlessly as possible. The parts that make up a computer, and the components you may have to buy to achieve some desired goal, are the subjects of the next chapter.

chapter 4

Nuts and Bolts

Nuts and bolts refer to the devices, parts, and individual components that make a computer what it is. Obviously there is a great deal more to computers than a pile of old screws and washers, but the term nicely points out that basically all computers boil down to the same thing—parts. Computers are made up of electronic parts, which, as we found out earlier, require programs to direct how they shall work. Since the chief function of the computer is to perform the operations indicated by the user, there must be a communication link between the computer and the user. This link is made up of the things needed in a computer to get it to do what the user wants in a quick, simple, and efficient manner.

In the future one can imagine that getting a computer to do something such as shine your shoes may be as simple as saying "Hal, shine my shoes." Voice communicaion with computers is definitely accelerating, and there are already devices on the market that can be attached to a computer which recognize 16 words, spoken by the *user's* voice. But today the personal computer user is faced with a more complicated situation. There is a broad range of computer products for the home and it seems to be rapidly expanding. Making any kind of intelligent purchase decision requires that you carefully define what you want to do first. Your

computing goals will then determine the type of hardware that you will need.

So, in this chapter we will explore just what devices make up a complete personal computer system. This is analogous to determining what things you need to put together a good stereo system. We will find out what communication devices hook up to a computer, and then take a look inside a computer. After reading this chapter you will be able to walk into any computer store and not only understand the various kinds of computers and computer products being offered, but also recognize their good and bad points.

THINGS THAT HOOK UP TO A COMPUTER

Basically there are two main divisions of "hardware" devices for computers. There are things that hook up to a computer, and there are things that go inside the computer. The things that hook up to the computer are the so-called "black-boxes" that allow us to communicate with the machine. Control panels, keyboards, printers, and video displays fit into this category. So do floppy disks, cassette recorders, and paper tape readers. All these devices in one way or another aid in getting things in and out of the computer, and are therefore called input/output (i/o) devices.

Control Panels

The simplest form of i/o device is the computer *control panel* often called the *front panel.* The front panel is usually made up of rows of switches and lights. Basic to this form of i/o device is the fact that the user must communicate in the fundamental language of the computer—binary. The switches correspond to *registers* or electronic temporary storage circuits inside the computer, and the user must methodically set up switch after switch. The lights on the front panel, usually light emitting diodes (LEDs), are used to tell us what "state" the computer is in. Obviously, this form of communication is rather awkward for people who are uncomfortable with binary or want to use a high level language. The chance of making an error using binary is great, and finding an error can take a long time. On the

other hand, communicating in binary gives us the most accurate and revealing picture of how the computer operates and, therefore, is better in an educational environment. Furthermore, computer front panels are often a valuable "debugging" aid as they allow the user to determine if there is some hardware malfunction.



Courtesy IMS Associates

Computer control panel.

Another version of the computer front panel is the *hex keyboard* and *7-segment display*. Found mainly in the more engineering oriented computers, hex keyboards condense the binary number system into the "hex" number system, which is made up of 16 characters, 0–F. The 7-segment displays can present these characters to the user, and the communication link is enhanced because it is easier to decipher hex than binary. For example the number 202 is 11001010 in binary and simply CA in hex.

The advantages of the computer front panel are often outweighed by the cost of the hardware it takes to make it. Since the goal of the semiconductor industry in developing LSI is to eliminate hardware, another type of front panel has evolved. This is called the "software" front panel. This is a rather tricky term, because what it really means is that the manufacturer has chosen to put the front panel functions inside a circuit in the computer. The principal input communication device is then the *ASCII keyboard*. The output device is the *video display*.

ASCII Keyboard/Video Display

The keyboard and video display belong to the higher level in computer communications. Now the computer is learning the language of people. ASCII* stands for *American Standard Code for Information Interchange.* It is a computer code that manufacturers have assigned to the letters of the English alphabet. This allows the computer to convert the letters on a typewriter keyboard to coded signals that can be stored, and later decoded as instructions. Also, the numerals of the regular decimal system (0–9) are represented,



Courtesy Lear-Siegler

ASCII keyboard/video display.

as are special characters such as periods, commas, hyphens, etc.

For output, we need to convert the ASCII characters stored in the computer back to letters of the alphabet. One device that does this is called the video display. If your computer has a video display, then circuits inside the com-

* Pronounced "ask-ee."

puter are used to generate characters that can either be displayed on a television set, or on a special screen called a crt (for cathode ray tube). These letters don't look exactly like regular typewriter letters, but are in fact quite readable.

When a television set is used with a computer, there is a device inside the computer called an "rf modulator," which transmits information to the tv like a regular broadcast signal. You tune the tv to an unused channel, and the computer's letters and messages appear on the screen.

Some computer products contain the television, computer, and keyboard in one single package. There is not really a complete television housed with the computer, but just the screen, or tube and its associated circuits. With this configuration the tuner of the standard tv is absent, making a much higher frequency response possible. As in stereo systems, the end result of better frequency response is better clarity and definition. Consequently this system allows more letters on the screen, and more detailed graphics.

The one serious drawback to both methods of video display is that there is no permanent record of the communication. As a new line of text appears at the bottom of the video display screen, the top line disappears. In order to solve this problem we need what is called a "hard-copy" device, one that will type or print on paper. Such a device has been in use for the last 50 years, and is called the teletypewriter.

Teletypewriter

The teletypewriter has long been a favorite of the computer user. The attributes of the teletypewriter are that it has a typewriter-like keyboard, and a "hard-copy" printing unit. The keyboard and the printer are usually in the same package, but the two devices are separate and run independently. This is why you see the words "local" and "line" on the Teletype*. They refer to how you connect the keyboard and the printer. For example, you may have the keyboard cause a character to be printed on the printing unit, or have the keyboard send the character to the computer,

* Tradename of Teletype Corp.

and then let the computer send the character back to the printing unit.

Although the Teletype® has an excessive amount of mechanical parts when compared to an electronic ASCII keyboard, it has the advantage of being an input and output



Courtesy Teletype Corp.

Teletype I/O device.

device all rolled into one package; however, some external circuits are required to "talk" to the computer. Even though the ASCII characters are sent over a single wire in what is called the "serial" mode (which is quite slower than the video display), the Teletype greatly increases the usefulness of the computer system.

Printers

With the advent of the electronic age, other devices which produce "hard-copy" output have been developed. There are devices which produce letters with tiny solenoids, on adding machine paper. Although these are limited to 40 characters per line, they are very inexpensive. Another type of printer uses heat-sensitive paper and a thermal print head. The quality of such a print is slightly below that obtained from impact printing, but the thermal system has greater reliability.



Courtesy Datel Systems, Inc.

Low cost printer output device.

There are also expensive line-printers which we see sometimes in movies standing next to giant computer installations. These are high speed output devices from which spews reams of paper, faster than anyone can read it. Although such devices are currently restricted to business data processing because of their high cost, you may see

some in the next few years appearing in computer and department stores.

In working with your home computer you will want hard copy for everything from printing your IRS Tax Forms to graphing your biorhythms. Because most printer devices require some type of mechanical method to operate, their cost continues to be rather substantial. It is therefore likely that we will see continuous change in the types of hard copy output devices being sold. When the first hard-copy device for under $10 is invented the world will be changed forevermore.

Paper Tape

Paper tape is not an i/o device but rather a storage media using paper in the form of a thin tape. Holes are punched in the tape to correspond to binary coded information. The tape may be coded in ASCII or some other code.

A *paper-tape reader* is a machine used to detect the holes in the tape and create an electronic bit pattern to send the computer. These machines run at fairly high speeds and make it possible to load information into the computer with little effort. Tapes can be used to store programs that can be used over and over. Of course the fact that the storage media is paper means the user will have to keep the tapes in a safe dry place. Even so, the tape may tear or crumble with age. Some tapes are soaked in oil to preserve them, but it is clear that paper tape has seen its better days.

Cassette Tape

A more modern form of storage media for the computers of today is magnetic tape, particularly the cassette cartridge variety. With magnetic tape we can store large amounts of computer information much like recording music. Depending on the technique used to record the data, a single cassette cartridge can store millions of bits of information. Today the more popular personal computer products have circuits built in that allow the use of a regular low-cost cassette recorder. There are also some products that use special high speed tape mechanisms. These devices may be expensive, but they allow the computer to take over control

of the tape machine and quickly assess large amounts of information or data. Such devices can search and find a particular item out of many on the tape.

Since cassettes have become such a popular form of storing computer programs it comes as no surprise that a standard way to record the information has been agreed upon among computer hobbyists. Called the "Kansas City Standard," this technique calls for users to agree to a standard



Courtesy Panasonic

Cassette tape recorder mass storage device.

recording format so programs can be exchanged. Given the competition factor, however, truly standard recording formats for programs among manufacturers will be the exception rather than the rule. But perhaps the nicest thing about cassette tape storage is the speed at which programs can be loaded into the computer. In some of the faster tape formats a typical BASIC program may take only 30 seconds to load into the computer.

Floppy Disk

The floppy disk is the newest form of secondary storage for computers. Like the cassette, the floppy disk uses mag-

netic material. However, a floppy disk is like a phonograph record with no grooves. Instead, a thin layer of magnetic material is coated on a flexible mylar record. The mylar disk is enclosed in a cardboard envelope for protection and support.

The major difference between the disk and tape storage is that the head, that reads or writes information onto the magnetic disk, can be positioned *anywhere* over the disk



Courtesy Peripheral Vision

Floppy disk mass storage device.

surface. This means information in any location on the disk can be accessed in any order. Contrast this with the cassette tape, where it may be required to go through all the information to get to one bit. This ability to randomly access information gives the floppy disk much greater access speed than magnetic tape, and programs can be almost instantly loaded into the computer. In fact, "floppies" are used in personal computer systems just like an electronic file of very large proportions. This means you can have many programs stored on a single disk.

Floppy disks come in several sizes, usually the smaller the floppy, the less total information that can be recorded, and the lower the cost of the drive mechanism. The major problem with the floppy is its cost, which usually runs ten times that of the cassette recorder. However, one could argue that with a floppy disk, a computer's power increases by ten times.



Courtesy ICOM, a division of Pertel Corp.

Microfloppy disk mass storage device.

Modulator/Demodulator (Modem)

The modem or modulator/demodulator is a form of i/o device that sends information over telephone lines. Therefore it allows one computer to talk to another, or a small computer to use the programs and power of a larger one.

Light Pen

The light pen is a device that "sees" light and darkness through a pen equipped with a tiny lens and some photoelectric circuits. Small bars of various widths can be printed on paper and encoded with computer data. The light pen can convert the bar codes back into a bit pattern and send it to the computer. Light pens can also be used to communicate with a program. The user touches the light pen to the screen and the computer figures out where the pen is and what it is touching. This way the user can draw shapes and special figures on the screen.

THINGS THAT GO INSIDE A COMPUTER

The things that go inside a computer are the components that have caused the small computer revolution. First there

is the famous microprocessor—the basic LSI chip that forms the heart of all personal computer systems. Also found inside the computer is the semiconductor memory which is used as a fast storage device to hold programs and data. Finally, computers contain i/o "interfaces." These are the circuits that cushion the signals from the real world devices so that the computer can use them.

Microprocessor Unit (MPU)

The MPU or "microprocessor unit" is the most important device in the personal computer. Since its inception back in the early '70s, the microprocessor has become the "darling" of the semiconductor industry. Today there are approximately 50 different microprocessor products. They differ mainly in the way that the manufacturer "sees" the end processing goals of the computer function. What this means is that some MPUs are designed to be used in low cost



Courtesy Intel Corp.

Microprocessor unit (MPU) on a board.

intelligent products like gas station pumps, or sewing machines, while other MPUs are designed for high cost computing uses, such as in business data processing, or sophisticated industrial controls. These units may have higher costs, but they also are faster and more accurate than their low-cost cousins. The most popular MPUs on the market today are the 8080, 6800, 6502, and the LSI-11.



Courtesy Apple Computer Co.

Single board portable computer.

Architectures

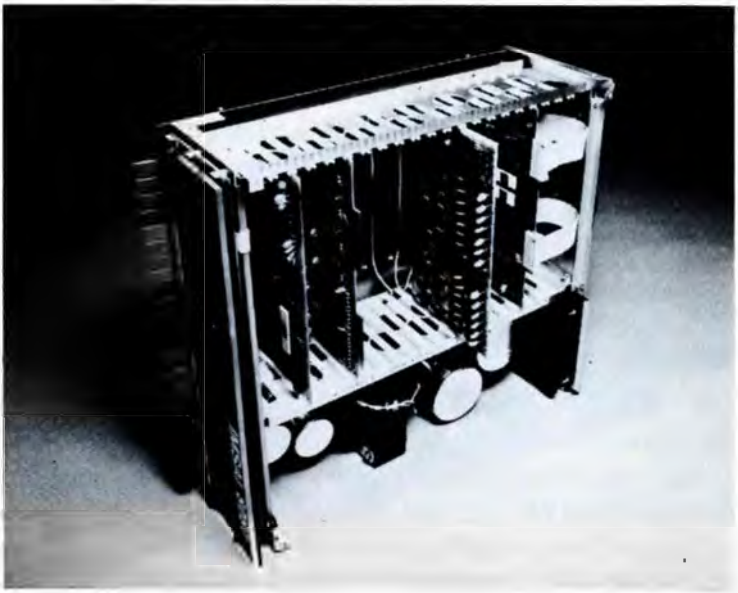
From a packaging standpoint two distinct computer "architectures" are in use today. One is the "single-board" concept where the computer and all its semiconductor memory is squeezed onto a single board. The other concept is the "backplane" computer. This is a more flexible arrangement, with a "mother" board made up of rows of plugs with their pins all wired in a special pattern. Various boards plug into the mother board so that any computer chip or memory combination can be used.

The "backplane" computer has further evolved into another ad-hoc hobbyist standard called the "S-100" bus. This is a backplane wiring pattern developed by the manufacturer of the first really big selling personal microcomputer, which has since been embraced by a number of other com-



Courtesy Apple Computer Co.

Inside the single board portable computer.



Courtesy IMS Associates

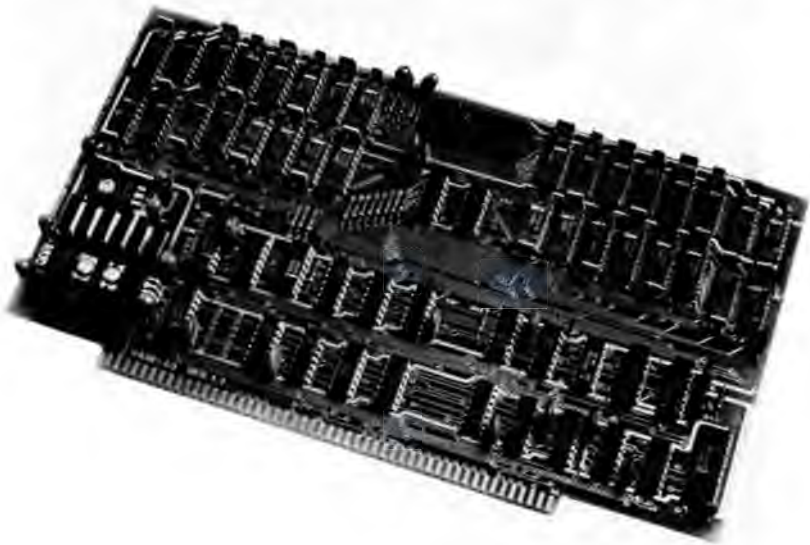
Backplane computer.

panies, as well as a large number of computer hobbyists. The S-100 bus standard means companies can make low cost and interesting peripherals for other computers, and have quite a large number of potential buyers.

The disadvantage of the S-100 bus is the overhead cost of the additional hardware, such as the mother board. To the personal computer user a super-flexible system is only as good as the ability to use it. In some cases flexibility may get in the way. Also, some of the companies that produce single board computers are making very interesting peripheral circuits, which make the issue of flexibility of the S-100 bus a moot point.

Memory

The MPU of any personal computing system can only execute or deal with one instruction at a time. After the MPU is finished with the current instruction it is ready for the next. In all computers the "memory" is the place where the instructions are kept until the MPU is ready for them. To make things simple, the instructions are stored in sequence, so that all the computer has to do to get the next



Courtesy IMS Associates

Computer memory board.

instruction in the sequence is to go to the next successive location in memory.

There are two kinds of memory devices found in the personal computer. When all the MPU does is "read" information from the memory device, we refer to the memory device as "read only." The read-only memory, usually shortened to ROM, is most often used when a certain program is to be used over and over in the basic operation of the computer. It is impossible to change the contents of the ROM, because it is made to be read only and there are no provisions for changing the program.

When the MPU wants to "write" information into the memory, as well as read information from the memory, we refer to the memory as "read/write," or R/W memory. R/W memories are often called RAM for random access memory.

Personal computer systems are usually advertised as having "so much RAM" and "so much ROM." Basically the idea is that the more RAM the better, because this is where most of your programs will be kept. Therefore the more RAM, the bigger your programs can be. If your personal computer uses a "high-level" language like BASIC it will most probably have a large amount of memory.

Memory sizes are measured in "bytes." A byte is a logical grouping of bits (usually eight) which can be used to store one element of data. It can be thought of as the memory necessary to store one character in ASCII code. Since the memory is made up of IC chips, it can be arranged in the computer in a variety of ways.

Comparatively, we speak of overall memory size in terms of blocks of 2^{10} (1024) bytes. This amount is commonly referred to as 1K bytes. Here again, this can be thought of as 1024 characters of memory.

The read-write memory is also known as "primary" storage for the computer since we can constantly put new information into the R/W memory, use it to do some function, and then erase the whole thing and start over. You will see ROM memory advertised as holding special programs called "operating systems" which do nothing more than tell the computer how to obey your wishes. The ROM has to work

with the main communications link on your computer as well. Some manufacturers are putting entire high level languages on ROM, so that the user does not have to deal with the problem of reloading the program every time there is an error made. Hobbyists like ROMs that can be reprogrammed. These are called PROMs for programmable read only memories.

At present, the cost of memory remains a significant portion of the cost of a computer. To make the cost of their systems seem less and to add to the concept of "flexibility," some manufacturers make it possible for you to add as much memory as you want. In the case of the backplane computers, this memory is on a circuit board, which plugs into the mother board, like all the other boards. The amount of memory on the board varies with who makes it, but most manufacturers choose to put as much as they can on a single board. Today a memory board ranges from 4K bytes to 65K bytes, and even a million bytes of memory can be purchased. The single board computers have IC sockets for the maximum amount of memory right on the main board. When you buy the computer you tell the manufacturer exactly how much memory you want. Using today's 16K-bit memory chips, 65K bytes of computer read-write memory can be installed in only 32 IC packages. Around the corner are memory chips of 64K bits, which means the entire computer memory could be implemented with only eight ICs! Obviously one can see that computers will get smaller and smaller in size.

Interfaces

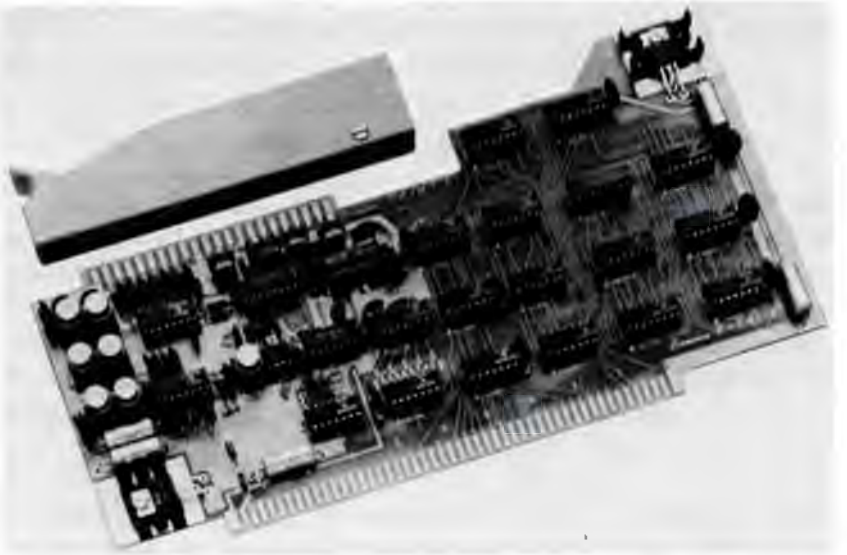
In the previous section we discussed the various i/o devices that are the communication links between man and machine. These i/o devices cannot however simply be plugged into the computer, and be expected to work. There is a significant amount of interfacing that must be done between the i/o device and the computer.

Interfaces are found in many places inside the personal computer. In the backplane computers the interface is on a board and usually has some kind of connector for hooking up to the i/o device. In the single board computer the inter-

face may be circuitry right on the board itself, or it may be a small board that plugs into slots on the single board.

There are as many interfaces as there are i/o devices. The "serial" interface is used to connect a device like a teletypewriter to the computer. A "parallel" interface is used when several wires must carry information to and from the computer. In certain cases what constitutes an interface and what constitutes an i/o device may become hard to decide. For example a music interface contains electronic circuitry for generating tones under command of the computer. The i/o device here is a regular speaker, or perhaps a complete stereo system, depending on what electronics the manufacturer has included on the interface board. A universal controller board for the home may contain circuits for controlling your lights and energy consumption. The i/o device here is the light bulbs and various appliances around the house.

Some of the most complex interfaces are to be found in the floppy disk systems. These interfaces may be complete computers themselves, which share the memory of the main computer. Again because of "smaller-is-better" technology,



Courtesy Cromemco

Computer interface board.

we will no doubt see these interface units also shrink to tiny proportions.

Of all the computer devices, inside or outside, it is the i/o device and interface that usually cause the most trouble. Studies have shown that the parts most likely to fail in a computer are the connectors! Since people must insert, plug, and otherwise force connectors to open and close, the chance of damaging a connector, getting it backwards, etc., is high. Furthermore, the elements of the conductor may be exposed to harsh environments, and can be oxidized so badly from the atmosphere that they will cease to work. LSI computer circuits on the other hand, are hermetically sealed from the atmosphere in epoxy or ceramic packages. They are also inaccessible to human hands and therefore have fantastic lifetimes. The average solid-state component has a MTBF (Mean Time Before Failure) of 7.5 years. It is unlikely, therefore, that your computer circuits will go bad. More often your problems will be caused by a 50-cent phone jack that makes a bad connection to your cassette recorder.

chapter 5

Getting Started

In this chapter we will find out how one goes about getting started in personal computing. You can approach your involvement with computers from several directions, some of which may even increase your earning power as you learn to use the computer. We will see how computers are becoming cheaper, easier to use, and more powerful. Finally, we will discover how to get a computer for free.

EDUCATING YOURSELF

Like any hobby, personal computing requires a certain awareness of computer subjects. It does not mean PhD-level understanding, just a simplified knowledge of certain concepts, and a feeling for some of the types of problems you may encounter in using a computer. You will want to discover right away what today's computers can do. You will also want to see a personal computer in action.

Become Aware of Computers

Start your journey to computer land by visiting a computer store. There are hundreds now, and thousands to come. The telephone companies are already making a special heading "Computer Stores," in the Yellow Pages. At a computer

store you can sit down and personally experience one of many different computer systems. You can play computer chess, or Star Trek, or many other interactive games. You can look at the various items offered for sale. Usually the magazines of small computing are offered, as are books and learning materials on microcomputers. Ask for a demonstration. Get an employee to tell you his personal reasons for using a computer. Find out what these devices are capable of doing. Finally ask for the names of some local computer clubs, and take the next step.



Become aware—visit a computer store.

Visit a Computer Club

Perhaps the quickest way to get started in computing is to find a group of people with similar interests. There will always be someone who knows something you do not. Computer people love to trade information. In fact one of the most interesting aspects of computing is its gossip. There are clubs springing up constantly, and there is probably one within 25 miles of where you live.

Clubs offer all kinds of formats, with lectures, clinics, demonstrations, product previews, show and tell sessions, workshops, panel discussions, and tape slide programs. Some clubs have a "random access" period where everyone has a chance to make an announcement.



Exchange ideas—visit a computer club.

Before you go to a club, think about what you want to do with a computer. Plan out how it might work and why you think that it is important. Bring this information with you to share with others; or find some special aspect of a project to master, then see if anyone can use your energy. Whatever you do, don't just stand around and look.

Go to a Convention or a Computer Fair

Another growing phenomena among computer hobbyists are the so-called Computer Faires (sic), conferences, expositions, and conventions. These are highly charged, dynamic events; often hundreds of companies display their products, present lectures, award prizes, hold drawings, show movies, have special contests for the best computer, etc. You can collect an incredible array of literature for free. Sometimes you can even cajole someone into giving you a manual. If



Discover new products—visit a convention.

you are thinking about how to get the money to buy your first computer, then first try a smaller investment—reading.

Read, Read, Read

In order to ask intelligent questions you need to gather some basic information on your own. The fastest and cheapest way to get acquainted with a hobby is to read magazines and books on the subject. The magazines on personal computing have grown rapidly in number and more are certainly on the way. The magazines claim personal computering will be *the* biggest hobby, because it includes all other hobbies! Their pages contain articles on every imaginable aspect of home computing. Computer magazines offer insights into the future, and are proving grounds for different ways to disseminate information (one magazine is now publishing certain articles in what is called "machine readable format"). This allows your computer to read the information from the magazine page and put it directly into its memory.

Our suggestion is to purchase, or borrow, at least one issue of all the magazines, and use the "reader service"



Read to learn—literature saves time and money.

postcards in the magazine to send for advertisers' literature. All you have to do is circle numbers on the card which correspond to the numbers under each ad. This literature will provide you with hours of interesting and low-cost reading, and be an educational experience as well.

Some of the more popular of these magazines include:

Byte
Creative Computing
Doctor Dobbs Journal of Computer Calisthenics and Orthodontia
Interface
Interface Age
Kilobaud
Personal Computing

You can find these magazines at some newsstands (especially around heavy technological areas), libraries, and schools; or you can write to the magazines and ask for a sample issue. Get their addresses at your library.

Are You in the Deep or on the Surface?

There are basically two general types of personal computer users. One, which we'll call the "typical user," is simply concerned with getting the computer doing something,

like figuring their income tax, or playing neat games of skill. The other type, which we'll call the "hobbyist" is concerned with many aspects of computers. The hobbyist enjoys programming languages, electronic circuits, and, in general, the "technical" side of computers. Since the needs of these two groups of personal computer users are so different, and the market is still changing, let's examine both levels of computer involvement.

If you are a hobbyist then you are probably "in the deep," and plan on making computers your profession. In this case your path involves a serious learning commitment. You will have to study basic electricity, chips, logic, computer math, programming, and computer systems. You may plan to become a consultant in the personal computing field, in which case you will really have to know your stuff. Or you may just enjoy creating new applications for computers. The hobbyist will consider building his own computer from a kit, and constructing special peripheral circuits for it.

If you are a typical user then you are more interested in what the computer is doing, than in how it does it. In your case the company that sells the computer will provide you with all the parts and accessories to do what you want. You may have to get a programmer consultant from outside the company if you want to do something special, but the manufacturer will supply all the hardware.

The basic difference between these two groups is that the hobbyist has a much greater flexibility of computer applications. He can single-handedly take on extremely sophisticated applications and probably get them working in short order. The typical user, on the other hand, can only choose from what the manufacturer has to offer. Because of these differences, companies recognize hobbyists as the pioneers of personal computing. Manufacturers watch this group carefully to get new ideas for creative computer products for the typical user group.

The typical user of computers will probably need to learn very little about how they work. But just as a stereo owner needs to know how to operate the volume and tone controls, so the personal computer owner will at least have to know how to use a keyboard. (This doesn't mean, however, that

you have to know how to type. You may only be entering numbers.)

If you are interested in really "getting deep" into computers in a big way, then why not start your education right here. You now know enough to walk into any computer store and not be shocked out of your wits. The next logical step is to pick up a few books and see if your interest is still aroused. Write the various book publishers and ask for their catalog of current offerings and prices. Also, the magazines listed previously will have advertisements of books related to the computer field.

BUYING A COMPUTER

Ten years ago anyone reading this heading would have laughed. "Buy a computer? Got $100,000?" But buying a personal computer will soon be as commonplace as buying a calculator. You will walk into a major department store, try out the various computers, ask the salesperson questions, and probably walk out with last decade's equivalent of a million dollars in computer equipment. Given the rapid changes in computer technology, the personal computer will hang over your shoulder in a carrying case, and in a few years will shrink to the size of a small camera.

Until that time, however, buying a personal computer may be a tricky job. Much will depend on just what you want the computer to do. If, for example, you just want something to keep the kids occupied, which is also educational, you may go out and spend $50 to $200 on a computerized tv game. But if you want to control the electrical consumption in your home, run the air conditioning system, and calculate your income tax, things may be quite a bit different. A hobbyist would have no problem here, but the typical user will have to wait until some company sells the entire application, or learn to be a hobbyist.

A resourceful person would be wise to just study computers for a while. Given the volatile changes taking place in the computer marketplace, the concept of waiting (as many people learned with calculators), may prove to be quite an advantage. Computers will definitely drop in price, although not as dramatically as the pocket calculator. One



Buying your personal computer is exciting.

can certainly envision all kinds of products calling themselves computers, like "smart" appliances, microwave ovens, intelligent games, etc., and this will make things seem even more complicated. But, the proverb "know what you want to do" holds. Don't consider a smart tv game a computer if all you want to do is regulate your electricity.

FREE COMPUTERS

Everyone knows you can't get something for nothing. At least that is what the old proverb says. But computers are

an exception. Given a good imagination, and a powerful microcomputer, an average high school student can start a business and have the computer pay for itself.

Today low-cost microcomputers are making unique business ventures possible. Services such as mailing label preparation, manuscript word processing and editing, classified newspapers, and general data processing can be based around a personal computer. Computer dating, club organization, family budget planning, nutrition analyzing, even weight reduction can be centered around a good computer.

The trick to getting a computer for free is figuring out how to get it to produce income. Perhaps you can write programs on it and sell them to magazines or companies. Perhaps you can develop a unique peripheral for your computer and sell it in the hobbyist marketplace. Or maybe you can develop a special application on your computer such as solar heating or energy regulation for the home, and then interest a manufacturer in buying it outright. Whatever you do, don't limit your imagination. One computer hobbyist sold his computer application to a farmer; it weighed chickens and saved him $2,000 per month in overweight packages!

appendix **A**

Glossary of Computer Buzz Words

The following glossary is designed to familiarize you with the language of the small computer community. The best way to use it is to read the entire glossary from A to X. Each buzz word is defined in simple terms and used in a short sentence to illustrate its meaning.

A

A/D Conversion—An A/D (Analog/Digital) conversion measures an input voltage level, and then outputs a digitally encoded number corresponding to the voltage. This provides a relatively simple way to get signals from the outside world to the inside of a computer. "That's the fastest *A/D conversion* I've ever seen."

Algorithm—The sequence of steps to be followed to arrive at a solution to a problem. It is usually a programming procedure that uses "iteration" to produce the desired result. Frequently algorithms are named after their originators. "The *Widro-Hoff LMS algorithm* is a programming procedure that removes 'noise' from a signal."

Alphanumeric—The set of symbols containing the letters A–Z (alpha) and the numbers 0–9 (numeric), as well as special punctuation characters. "Most computers use *alphanumeric* characters."

Applications Program—A program that actually solves a specific problem, as opposed to the programs that perform system functions, such as assemblers, etc. "The *applications program* is rather long."

Assembler—A system program that allows programming in the mne-

monic codes of assembly language. Assembler programs are one step above binary machine-language programming. "Many computer hobbyists use *assemblers.*"

Assembly Language—A low-level symbolic programming language, that uses mnemonic codes such as ADD, LDA, SUB, etc. Historically the first programming aid. "What is the *assembly language* format for add?"

ASCII Character—Short for *A*merican *S*tandard *C*ode for *I*nformation *I*nterchange, ASCII is the most widely recognized 8-bit code for representing alphanumerics of the English language. Pronounced "*ask-ee.*" "The *ASCII* code for 7 is 00110111."

B

BASIC—Stands for *B*eginners *A*ll purpose *S*ymbolic *I*nstruction *C*ode. BASIC is a widely used beginners high-level programming language. Like most high-level languages, it uses powerful statements like "10 PRINT X/Y + 1" rather than machine codes or mnemonics. "Hobbyists love *BASIC* because it's so much like English."

Baud Rate—The number of bits per second a computer is capable of sending or receiving. Baud rate usually varies from 300 (teletypewriter speed) to 9600. "The *baud rate* of a typical computer is 300."

Binary—The base-two number system which uses the digits 0 and 1. The first four numbers in binary are 00, 01, 10, 11. Computers use binary because electronic components can be made cheaply to switch between two states such as +5 volts and ground. "To get a feeling for how computers calculate, try counting in *binary.*"

Bit—A contraction of the words *B*inary dig*IT*, a bit is the smallest unit of computer information. Several bits together make up a letter, number, or word. "Eight *bits* is a byte."

Bootstrap—The general technique of using one thing to aid in the start of another thing. In computers, a short program that allows a larger program to be entered into the computer. "First load the *bootstrap* loader, then load the program."

Branch—The process of taking a departure from the normal sequence of operations in a computer program. Also a programmed jump based on continuous testing in the computer program. "Computers make good use of *branch* instructions, such as BNE (branch on not equal)."

Bug—Something which causes the computer program to malfunction. Usually, but not always, due to an error in the logic of the program. "Not another *bug!*"

Byte—A group of adjacent bits. A specific portion of a binary word. The most common size byte is 8 bits, although 16 is also used, as well as 4 and 12. "I always think of a *byte* as 8 bits."

Buffer—A temporary storage location for holding a number of bits. For instance a keyboard buffer may hold several ASCII characters, each of which is 8 bits long. "Your *buffer* overflowed."

C

Chip—Another word for "integrated circuit," this is a technique where thousands of electronic semiconductor components can be mass produced on a tiny piece of silicon (sand). "Did you know there's a *chip* in your telephone, and one in your car, and one in your watch?"

Collate—To compare or merge two things into one thing. Usually refers to files in the computer. "Lets *collate* the data."

Compiler—A compiler is a computer program. Its purpose is to convert high-level language statements typed in at a keyboard to machine code for the computer. "*Compilers* are more efficient than 'Interpreters' when it comes to saving memory space."

Complement—The number produced by performing a basic operation on the original number. In binary the complement of a number is found by reversing all the digits, i.e. 101 complemented is 010. "Certain computer instruction codes *complement* a number in a register."

Core Memory—The early computers used little doughnuts of ferrite material to store bits. Because ferrite is a magnetic material a core memory doesn't forget its contents. Bubble memory may revive the concept of core memory. "Time to do a *core* dump, and find out what's in it."

Console—The part of a computer system that is used for communication between the operator and the system. The console usually contains switches, lights, and keyboards specifically for man-machine communication. "As usual the *console* is dead."

CRT Display—A type of computer terminal that displays information on a television-like screen. This screen is the face of a cathode ray tube (CRT). "That's really a fast *CRT*, but I don't like the green characters."

D

Debug—The art of removing errors, or "bugs," from a computer program. Usually the crucial stage in developing a good program. Unfortunately, not all bugs are always found. "Always allow at least 10 minutes per BASIC statement, for *debugging*."

Disk—A type of mass storage technique that stores information on magnetically sensitive surfaces, about the size of a 45-rpm record. "The cheapest form of mass storage in 1977 was the floppy *disk*."

DOS—Stands for *D*isc *O*perating *S*ystem. A computer system that uses a magnetic disc to contain all the routines and programs that

run the computer. An FDOS is a floppy disk-based DOS. "Soon there will be Bubble Operating Systems, and the *DOS* will be obsolete."

Dump—The action of causing the pattern of binary bits in a computer to be displayed on an output device. "By doing a *dump* we'll determine the bad bit."

Dynamic Memory—A type of memory arrangement where all the various memory cells must be refreshed every so often so they keep their proper state. Although a less-power-consuming form of memory than static memory, dynamic memory requires complex addressing circuits. "Sometimes you hear about pseudo-*dynamic* memory."

E

Editor—A special computer program that allows changing, moving, and general editing of statements. Editing is a simple form of word processing, but is often reserved for changing assembly statements. "An *editor* is a fantastic tool for fixing computer programs."

EPROM—Stands for *E*lectrically *P*rogrammable *R*ead *O*nly *M*emory. A type of memory that can hold data forever. EPROMs are programmed by an electrical process that establishes each bit as a 1 or a 0. EPROMs are often used to hold the monitor or operating system programs. "You can buy special *EPROM* programmers, but they are expensive."

F

File—A sequence of related records, frequently found in floppy disc, cassette, or mass storage systems. A file is an abstract name for an aggregation of data sets in the form of a series of characters or bits which together may describe some quantity or numeric value. "The disc has fanstastic *file* commands."

Firmware—Software or programs that are permanently stored in ROM or EPROM. Also any microprogram that causes a machine to emulate a certain instruction set. "The nice thing about firmware is that you can easily change it (compared to changing hardware)."

Floppy Disk—Disc storage where the magnetic medium is located on small flexible discs, which are encased in a protective cardboard container. Floppies are somewhat slower than "hard" disks, they wear faster, but are less costly. "Wait till they make a micro-*floppy* disk."

Flowchart—A diagram that represents the logic and reasoning behind a program or a circuit. "Programmers are always forgetting to *flowchart* their programs."

FORTRAN—Stands for *FOR*mula *TRAN*slation, and refers to a computer language that is used for computational-type program-

ming, especially when involving algebraic problems. A compiler language. "*FORTRAN* is almost as easy as BASIC, but much more mathematical."

H

Handshaking Logic—A type of computer interface design where the computer sends a signal, and waits until the interface sends a signal back signifying it is done. The back and forth communication is like shaking hands. "*Handshaking Logic* makes troubleshooting easy."

Hex—Short for hexadecimal, the base-16 number-system is commonly used in computers because it is easier to remember FF than 11111111. "Compared to binary, *hex* is much easier to work with."

Heuristic—A special program that has the ability to alter itself to improve itself. Often associated with artificial intelligence (AI), heuristics are used in many non-AI computer programs. "I really enjoy chess playing *heuristics*."

I

IC—Stands for *I*ntegrated *C*ircuit. *See* Chip.

Instruction Set—The "menu" of instructions a computer can execute. Unless computers have identical instruction sets, they cannot run the same programs. "The XYZ-80 has over 180 instructions."

Interface—A circuit that allows one type of electronic unit to communicate with another electronic or mechanical device. Chiefly used as a buffer between computers and mechanical devices. "Better check the serial *interface*."

Interpreter—A computer program that converts high-level-language statements to "machine" code for direct computer operation. Unlike a compiler, however, it executes the statements immediately, instead of later. BASIC is an interpreter language. "Most *interpreter* languages are slow."

Interrupt—An external event that overrides any current computer action and causes a certain special program to be run. Frequently "priorities" are established among interrupts so that several devices can interrupt a computer. "Do computers mind being *interrupted?*"

I/O—Stands for *I*nput/*O*utput. A generalized expression for the action of sending information into a computer (I or Input) and getting it out of the computer (O or Output). "Try wiggling the *i/o* cable."

L

Looping—A programming technique where a portion of a program is

repeated over and over, until a certain result is obtained. "Try *looping* until the bit goes high."

LSI—Stands for *L*arge *S*cale *I*ntegration. A way of making denser and more complex integrated circuits. Eventually LSI will be replaced by VLSI (*V*ery *L*arge *S*cale *I*ntegration), and VLSI by ELSI (*E*xtremely *L*arge *S*cale *I*ntegration). "General Motors uses advanced *LSI*-hybrid circuits in fuel regulators."

Line Printer—A very high speed printer output device that can type text at several hundred lines per minute. A very expensive computer peripheral, but also a very powerful one. "I would buy a *line printer* if I could sell some service and make a profit to pay it off."

M

Machine Language—The lowest level of computer programming; this is the only language the computer can understand without the aid of another program. Looks like: . . . . FF FF FF FF B8 C9 D9 C0 . . . . "Programming in *machine language* isn't quite so bad."

Macro—Short for macroinstruction. An instruction that generates a larger sequence of instructions. "Good assemblers have many *macros*."

Microprocessor—All the essential electronics of a computer miniaturized to a single chip the aize of a pin head. Contained usually in an IC package with 18 to 40 leads. "*Microprocessors* keep getting smaller."

Mnemonic—Pronounced "new-monic." A short word or group of letters that stands for another word, and ia easy to remember. For instance, "Add X to the Accumulator" might be abbreviated "ADDX." "This computer has elegant *mnemonics*."

Modem—Stands for *MO*dulator *DEM*odulator. Usually connects between the computer and telephone line and converts digital signals to audio tones and vice-versa. "A good *modem* is simple to use."

MPU—Stands for *M*icro *P*rocessor *U*nit. Another way to say microprocessor. "Motorola makes an *MPU* called the 6800."

N

Nanosecond—One billionth of a second, or 1/1000 of a microsecond. "Some of today's faster personal computers operate in the *nanosecond* range."

Nested Program—A program which is contained as a part of another larger program. "The printing subroutine is *nested* within the main program."

Network—An interconnected group of computers, terminals, or even

telephones. "Computer *networks* are becoming more and more popular."

NOP Instruction—A computer instruction which has no effect on computer operation, and is therefore called a no-op. These are often used to reserve space within a program for possible future expansion. "Leave a *NOP instruction* after the last byte of the program."

Nonvolatile Memory—A form of computer memory that will store information for an indefinite period of time with no power applied. "Magnetic core is *nonvolatile memory*, as are ROMs and EPROMS."

O

Object Program—A program that is in machine executable form. This means that the program is most likely to be in some sort of a binary pattern, ready to be used by the computer. "Object programs are very difficult for the average person to understand."

Octal—A number system based upon the number 8. There are eight digits in the octal system—0 through 7. "The use of the *octal* system makes programming easier than when using binary."

Off-Line—Refers to computer equipment which is not at the time directly connected to the computer. "Take the printer *off-line* for a minute."

On-Line—Describes the condition of a piece of computer equipment which is directly connected to the computer. "This system has 5 megabytes of *on-line* disc storage."

Operand—The object or "target" of some program operation, usually a number or variable that is involved in some arithmetic operation. "The *operand* of that instruction has not been defined."

Operating System—A group of special programs that are used in various combinations to make a computer easier to use. "Some computers have very flexible *operating systems*."

Operation Code—Sometimes referred to as "Op-code" this is the electronic binary pattern that directs the computer circuits to perform some particular operation. "The *Op-code* for an ADD instruction is 11000101."

Overflow—The result of performing an arithmetic operation within the computer which yields an answer that is too large to be contained in the MPU. "Adding two large numbers together may cause an *overflow* to occur."

P

Page—A term often used in conjunction with computer memory. A memory page contains some fixed number of bytes. "The keyboard input buffer occupies one *page* of memory."

Paper-Tape—A means of storing binary information by punching small holes in a continuous strip of paper. This is most common in teletypewriter-related equipment. "Many programs are available on *paper-tape*."

Parallel—Pertaining to events that occur simultaneously. Most commonly used in conjunction with the transmission of binary information, where all the bits of a given byte are sent at the same time. "The ASCII keyboard is a *parallel* device."

Parameter—A special element of data that is to be used as a condition for some type of processing. "There are several *parameters* involved in processing this data."

Parity—A means of determining the validity of computer data stored in binary. "A *parity* error occurred while reading the data."

Patch—A quick change to an existing program to cause it to operate differently. "Let's *patch* in a jump instruction at a key point."

Peripheral—A device which is connected to the computer in order to provide communication with the real world. "There are many different kinds of *peripherals* available for your personal computer."

Photoelectric—Pertaining to the use of light to detect the presence or absence of holes in paper tape, or punched cards. "*Photoelectric* readers are faster than mechanical ones."

Picosecond—One-millionth of a microsecond, or 1/1000th of a nanosecond. "A *picosecond* is almost too small an interval of time to conceive."

PL-1—A very powerful high-level programming language, generally found in use on large computer systems, but which will inevitably be used with the personal computer. "Programming in *PL-1* is a snap."

R

Random Access—Pertains to the storage of data in memory of some sort. Random access means being able to access any location of memory individually, as opposed to "serial access" memory which requires that the memory locations be accessed in sequence. "Floppy discs are *random access* devices."

Read—To sense, or obtain the state of the data either in memory, or from an input device. "*Read* in the program from cassette tape."

Real-Time—An expression used in discussing a type of computer operation in which the computer is interacting with events in the world of people, rather than of circuits. Generally speaking, the interaction must take place in a fast enough time so as to be able to influence or react to the particular "people" event in progress. "The computer can monitor the apparatus in *real-time*."

Record—An assemblage of several data elements that are all in some way related, and are handled as a unit. "How many *records* can the disc file contain?"

Register—An electronic circuit within the microprocessing unit that is capable of storing one or more bytes of information. The most common register is the accumulator register, in which all of the arithmetic operations are performed. "When the operation is complete, the result will be in the A register."

Routine—A group of program instructions which accomplishes a particular task that needs to be done frequently. A group of instructions can be used over and over again, simply by referring to it from another part of the program. "Write a *routine* that finds the largest of five numbers."

S

Seek-Time—The length of time required to find a record of data, generally with reference to disc files. "The average *seek-time* for a good floppy disc is in the millisecond range."

Sequence—Pertaining to the order that things (bits, bytes, records, or files) are arranged. "It may be important to maintain alphabetic *sequence* in some applications."

Serial—An arrangement where one element of data is linked to the next so that progress must start at the beginning and proceed from the first element through the next, and on to the finish, never skipping any. "Cassette tape files are stored in *serial* form on the tape."

Software—A nickname given to computer programs, which, of course, are not composed of electronic circuits, or hardware. "There is a lot of *software* available for some personal computers."

Statement—Often used when discussing high-level languages such as BASIC. A BASIC statement is a single unit of program command, of which there are many making up the entire program. "The PRINT *statement* causes the data to be displayed on the video display."

Storage—Sometimea used as a synonym for memory. This might be "core storage" or "disc storage" or any other form of computer memory. "There is a lot of space for program *storage* on a floppy disk."

Store—The act of saving some data in a computer memory. The data can then later be "retrieved" or "read" and used in further operations. "*Store* the results of the test in memory."

Subroutine—*See* Routine.

System—A group of programs and subroutines that are all related

to processing for a particular application area. "There are good general ledger *systems* available for CPAs."

T

Terminal—An Input/Output device that can be connected to a computer in order to communicate with it and control processing. "A common *terminal* consists of an ASCII keyboard and a video display."

Time-Sharing—A process in which a single computer divides its time among several tasks to be done. This makes it appear as if all the tasks were being processed simultaneously. "The cost of *time-sharing* on a large computer decreases as the number of people sharing the time increases."

U

Update—To make current. As with programs that have been modified to comply with some change in circumstances. Or, any form of data, such as a disc file record, might be renewed with more current information. "It is important to *update* your system as new features become available."

V

Video Display—A computer output device which presents the data to the user in the form of a television picture. This picture can either be in the form of printed characters, or as a video image of some sort. "One drawback of *video displays* is that there is no hard copy."

Volatile—Pertaining to the characteristic of certain types of computer memory which lose their contents when power is removed. "All of the application programs can be stored in *volatile* memory."

W

Word—A term used for years in the computer world to describe a logical group of bits. "The term 'byte' has become dominant for the term *word* in personal computing."

Write—Often used synonymously with "atore," this word means to deposit data into some form of computer memory. This might be magnetic memory, or disc memory, or writing information onto magnetic tape. "Data can be read back after we *write* it onto the disk."

appendix **B**

Personal Computing Acronyms

AC—Alternating Current
ACC—Accumulator
A/D—Analog to Digital
BCD—Binary Coded Decimal
BPS—Bits Per Second
CCD—Charge Coupled Device
CMOS—Complementary MOS
CPS—Characters Per Second
CPU—Central Processing Unit
CR—Carriage Return
CRT—Cathode Ray Tube
D/A—Digital to Analog
DC—Direct Current
DIP—Dual In Line Package
DMA—Direct Memory Access
ECL—Emitter Coupled Logic
EPROM—Electrically Programmable ROM
EOR—Exclusive OR
FAMOS—Floating Gate Avalanche-Injection MOS
FET—Field Effect Transistor
FIFI—First In First Out
GIGO—Old Programmers Adage: "Garbage In, Garbage Out"
GP—General Purpose
HEX—Hexadecimal
I/O—Input/Output
IC—Integrated Circuit (Chip)
INT—Interrupt
I^2L—Integration Injection Logic
K—1024
LED—Light Emitting Diode
LIFO—Last In First Out
LP—Line Printer
LPM—Lines Per Minute
LSB—Least Significant Bit
LSI—Large Scale Integration
MPU—Microprocessor Unit
MOS—Metal Oxide Semiconductor
MSB—Most Significant Bit
MSI—Medium Scale Integration
MUX—Multiplexor
NMOS—N-Channel MOS
OV—Overflow
PC—Personal Computer
PC—Program Counter
PLA—Programmable Logic Array
PMOS—P-Channel MOS
POS—Point-Of-Scale

PROM—Programmable ROM
PSW—Program Status Word
Q—Positive Logic Output of a Flip-Flop
$\overline{Q}$—Negative Logic Output of a Flip-Flop (also called "not Q")
RAM—Random Access Memory
ROM—Read Only Memory
RTC—Real Time Clock
R/W—Read/Write
SOS—Silicon On Sapphire
SR—Shift Register
SSI—Small Scale Integration
SUB—Subroutine
TSS—Time-Sharing System
TTY—Teletypewriter
TTL—Transistor Transistor Logic
UART—Universal Asynchronous Receiver Transmitter
USART—Universal Synchronous-Asynchronous Receiver Transmitter
X—Index
XOR—Exclusive OR

your OWN COMPUTER

The personal computer has been touted as the next consumer product. But most individuals still wonder why. Much has been written of a technical nature on these new devices that provide more "computer power" in a small tabletop unit than could be obtained from the huge installations of a few years ago. However, little has been written that the average individual without an extensive background in electronics or computers can understand.

In this book the authors have removed the stigma of complexity and mystery that surrounds the computer and have succeeded in producing a simple, easy-to-understand book about these amazing devices.

The first chapter explains just what is a personal computer. Then Chapter 2 tells ways the personal computer is being used today to make life easier and more enjoyable. Programming, which sets the computer apart from other products, and makes it a multifunction instead of a single-function device like most other consumer products is covered in Chapter 3. Chapter 4 describes the various "hardware" devices such as input/output units, microprocessors, memories, interfaces, and many more. Each is explained in simple terms. The final chapter tells you how to get started in this field, whether you plan to use it for your home, hobby, or business. Two appendices give a glossary of personal computer terms and abbreviations.

This book has been especially designed to be your first investment in the personal computer field. It provides the beginner with the knowledge and confidence to utilize this marvel of our time.



Mitchell Waite (right) is an electronics engineering consultant with a wide background in computers and related technology. He received his electronics training from Heaids Engineering College, in California and has written articles on alpha biofeedback, music synthesis, parapsychology, and video games. His interests include yoga, children's books, ham radio (WA6MMS), space-time physics, computer games, and poetry. Mr. Waite is the author of *Projects in Sight, Sound, and Sensation*, also published by Howard W. Sams & Co., Inc.

Michael Pardee (left) is a data processing consultant in the San Francisco bay area. He studied computers at the College of Marin, in California. There, he worked on disc-based speech recognition and computer games. He has over eight years of experience in designing data processing systems for small businesses. Mr. Pardee's interests include ham radio (WA6KON), sailing, and the piano.

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