INTRODUCING
IBM PCjr

Introducing IBM PC*jr*

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About the Authors

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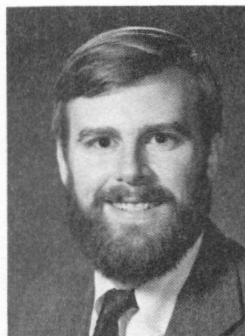
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Acknowledgments

Preface

On August 11, 1981, IBM shook up the young microcomputer industry by announcing the IBM Personal Computer. Despite some early negative predictions, IBM has since become the dominant force in the field of microcomputers. Over 500,000 IBM PCs have been sold, and the IBM PC has replaced the Apple® II as *the* industry-standard computer.

On November 1, 1983, history repeated itself when IBM announced the PC Junior, a new home computer. The effects of PC*jr* on the home computer marketplace had been felt for months prior to the computer's introduction. No product announcement in the microcomputer industry has been preceded by so much rumor and speculation.

When it was finally introduced, PC*jr* was greeted with great enthusiasm. Actually two machines in one, PC*jr* offers a 16-bit microprocessor, full color graphics capability, multivoice sound, and other exciting features. A large library of software for home management, education, entertainment, and programming is already available. The machine offers a level of performance never before seen in a home computer.

PC*jr* is also the first home computer to be compatible with the popular IBM Personal Computer. Perhaps most important, the PC*jr* is the first home computer *from IBM,* which virtually ensures the machine's dramatic success.

Who Should Buy This Book?

Anybody interested in this exciting new machine. This book is an introduction to the PC*jr* and covers every aspect, from the computer itself to the software programs that make it run.

Computer novices and experts alike will find *Introducing IBM PCjr* to be the best source of information about this new home computer.

If You Are Considering PCjr

If you are in the market for a home computer and are considering *PCjr*, this book will give you the information you need to make an intelligent purchase. If you already own a *PCjr*, this book is what you need to become better acquainted with the computer. Chapter 1, "Overcoming Fear and Uncertainty," will help you become familiar with some of the basic concepts and terminology of computing and should make you more comfortable with the whole idea of home computing.

Chapter 2, "An Overview," provides an overview of the computer, including the hardware, software, and expansion options. This chapter also assembles a "typical" *PCjr* system to show how much a *PCjr* costs. Also included is a brief history of the *PCjr*. Chapter 3, "The Hardware," introduces you specifically to the *PCjr* System Unit, the keyboard, the disk drive, and other hardware components.

The next two chapters help you understand *PCjr's* system software. Chapter 4, "DOS," focuses on *PCjr's* disk operating system. Both versions of the BASIC programming language available for *PCjr* are explained in Chapter 5, "Languages," which also discusses BASIC Compiler, assembler language, and *PCjr's* other popular programming language, Logo.

Chapters 6, 7, and 8 explain *PCjr's* large applications software library. Chapter 6, "*PCjr* for Personal Management," covers PC *jr's* personal management software, including Multiplan™, VisiCalc®, EasyWriter™, HomeWord™, and others. "*PCjr* for Education," Chapter 7, reviews each of *PCjr's* educational software packages, and Chapter 8 discusses *PCjr's* entertainment programs.

The cost of complete systems is considered in Chapter 9, "Putting It All Together." Chapter 10, "Where *PCjr* Fits," compares PC *jr* to other popular computers, including the Commodore 64™, the

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TI-99/4A, the Coleco ADAM™, and the PC*jr*'s older brother—the IBM PC. In Chapter 11, the authors speculate about the future of PC*jr*. Also discussed are possible future enhancements for the basic PC*jr*, including new hardware and software products.

The Next Step

After you buy your PC*jr*, you should consider purchasing Que™ Corporation's second PC*jr* book, *IBM PCjr Favorite Programs Explained*, by Don Kreutner. This book includes 40 BASIC programs for PC*jr* and will be available in January, 1984.

For now, we hope you like *Introducing IBM PC*jr and find the book both informative and enjoyable.

Happy Computing!

Introduction

Meeting the Roberts

The Roberts family—Jim, Molly, David, Rebecca, and Barney—live in a suburb of San Francisco. The Roberts recently bought their first home computer, an IBM PC*jr*.

Jim and Molly had searched for a computer that was powerful enough to be a "home office" system, but which also offered entertainment and educational software for the rest of the family. Several different home computers from a variety of computer companies had some good features, but none of these machines had all the features and capabilities of PC*jr*. It was the only computer to offer a full range of home management, entertainment, and educational software. PC*jr* also offered more options, like a modem and an inexpensive printer.

Since PC*jr* was their first computer, the Roberts wanted to buy from a leading company. One of the biggest reasons why the Roberts selected PC*jr* was that it is a product of the leading computer company, IBM. Sure, PC*jr* was more expensive than other home computers, but the Roberts believed it was worth the price. The final decision was easy: PC*jr* was the only computer that met all of the Roberts family's needs. After a few months with their computer, they couldn't be happier with their choice.

Molly

Molly Roberts is a marketing manager at a medium-sized retail chain store. A large part of her work involves developing marketing and advertising plans and evaluating the success of those plans. Her company recently acquired several IBM Personal Computers with the electronic spreadsheet Multiplan.

Since that time, Molly has become an avid Multiplan user. All of her projections and analyses are done with the program.

When Molly found out that PC*jr* can use Multiplan, she knew it was the home computer for her. Before the Roberts got their PC*jr,* she often worked late at the office because the IBM PC was unavailable at other times. Now that she has a PC*jr,* she sometimes brings her Multiplan work home. Since the Roberts have an IBM color monitor for their PC*jr,* she can work on it while the kids are watching television. She likes being home more and not having to wait in line to use an IBM PC at the office.

Molly likes her PC*jr* so much, in fact, that she sometimes stays at home during the day to work on her projections. Because her work at home has been so productive, her boss doesn't mind the occasional days she is away from the office. He knows that he's also getting a bonus from her for any time she spends working at home in the evenings. He is so pleased with this arrangement that

he wants to provide several other employees with PC*jr*s for their homes.

Molly also uses PC*jr* to manage the Roberts household. She just finished putting her address book "on line" with pfs:®FILE. Now she and the rest of the family can always find an address or telephone number quickly and easily.

Like many working mothers, Molly doesn't have as much time as she would like to plan her family's meals. She recently saw a cookbook program that can help her with menus. Currently, it is available for only the IBM PC, but she is hoping that IBM will introduce a version for the PC*jr*.

Jim

Molly's husband Jim is a CPA with a large accounting firm. Although it has a few personal computers, he hasn't used them much. The people who work for him do most of the computing, and he reviews their work. After Molly convinced him that the family should buy a PC*jr,* he has become a real microcomputing fan.

Jim uses the Home Budget, *jr* program to manage his family's finances. Even though he and Molly make a good living, college expenses for the kids are just around the corner, so Jim watches every dollar. Before he got PC*jr,* he used large sheets of accounting paper to prepare the family budget and track expenses. Now all of those records are stored on PC*jr*. It took Jim a while to learn how to use PC*jr* for this task, but now he wonders how he did the job without the computer.

With some help from Molly, Jim learned Multiplan in just a few weeks. He is now using Multiplan to develop a tax-planning program. Actually, work on this tax-planning system has become a new hobby for him. He constantly thinks of ways to expand and enhance the program.

Jim hopes to buy a PC*jr* Internal Modem and Dow Jones™ Reporter software soon so that he can use PC*jr* to manage the family's investments. Molly wants him to purchase the Personal Communications Manager program that will let her send messages back and forth to the office.
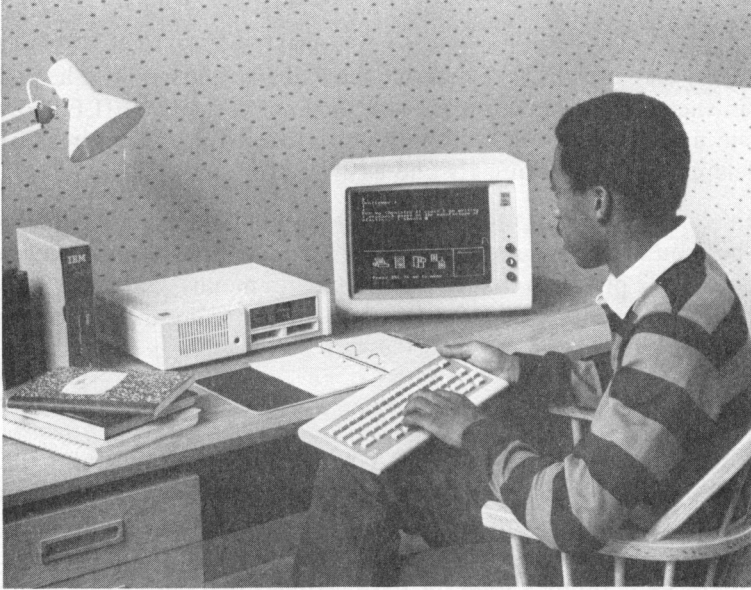
David

David Roberts is fifteen years old and a sophomore in high school. When his parents told him they were going to buy a home computer, he wasn't too interested, but now he's already found several uses for the system.

David uses pfs:FILE to keep all of the records for his paper route. Every month, using pfs:®REPORT, he creates a report that shows how much money he has made and exactly what each customer owes. Having computerized records has made David's job a lot easier. The computer-printed bills he sends out encourage people to pay more quickly. Because the information about his customers is so well organized, he'll have an easier time explaining his route to a substitute carrier next summer when the family goes on vacation.

David also uses PC*jr* to organize his stereo record collection. He is about halfway through logging his albums into pfs:FILE. He

wants to finish the job as soon as possible because he has acquired so many records that he can hardly keep track of them. In fact, while going through his collection and entering the information, he discovered some records he had forgotten about entirely.

David is also using the HomeWord word processor to write some of his papers for school. He claims he can get the work done faster and has actually come to enjoy writing on a computer. His teachers have noticed that his writing has improved (especially after the family bought the Word Proof spelling dictionary program).

Rebecca

Jim and Molly's daughter Rebecca is twelve. Last year, her school bought several computers, and she was selected to participate in a special computer workshop. She has loved programming ever since, but until the Roberts got PC*jr,* she could not practice her programming at home.

Now she learns BASIC programming almost every night. She has also mastered Logo and has asked her father to buy the Macro Assembler so that she can try her hand at assembly language programming. One of Rebecca's programs—a music program that uses PC*jr*'s multivoice sound—won honorable mention last month at the school's science fair. She wants to become a professional programmer and is already thinking about trying to sell one of her best programs, a math tutor for preschool children.

Barney

Eight-year-old Barney is Jim and Molly's youngest child. He likes the computer for one reason: video games! He has already mastered Scuba Venture and Crossfire® and is saving his allowance to buy Mouser. Barney has always been outgoing but is now the most popular kid on his block.

Although they wish that Barney would spend less time playing computer games, Jim and Molly are happy that Barney is learning to be so comfortable with the computer. His familiarity with it is beginning to pay off. He has been using Bumble Games™

to learn some math. The program is so much like a game that he has come to enjoy learning. Recently, he asked Molly to show him how to use Logo so that he can write a game of his own!

Computers for Everyone

The Roberts are the kind of home computer users for whom IBM designed the PC*jr*. You might say that the Roberts are "superusers": they take advantage of almost every capability offered by PC*jr*. Although you or your family may not use PC*jr* as extensively as the Roberts do, you probably recognized in their story several of the ways you would like to use a home computer. Do you like to make budget projections? Do you need a good home word processor? Do you want to create computerized files of your records? Do you have children who want to use a computer for programming or entertainment? If so, a PC*jr* is probably in your future. Read on and learn about this exciting new computer from IBM.
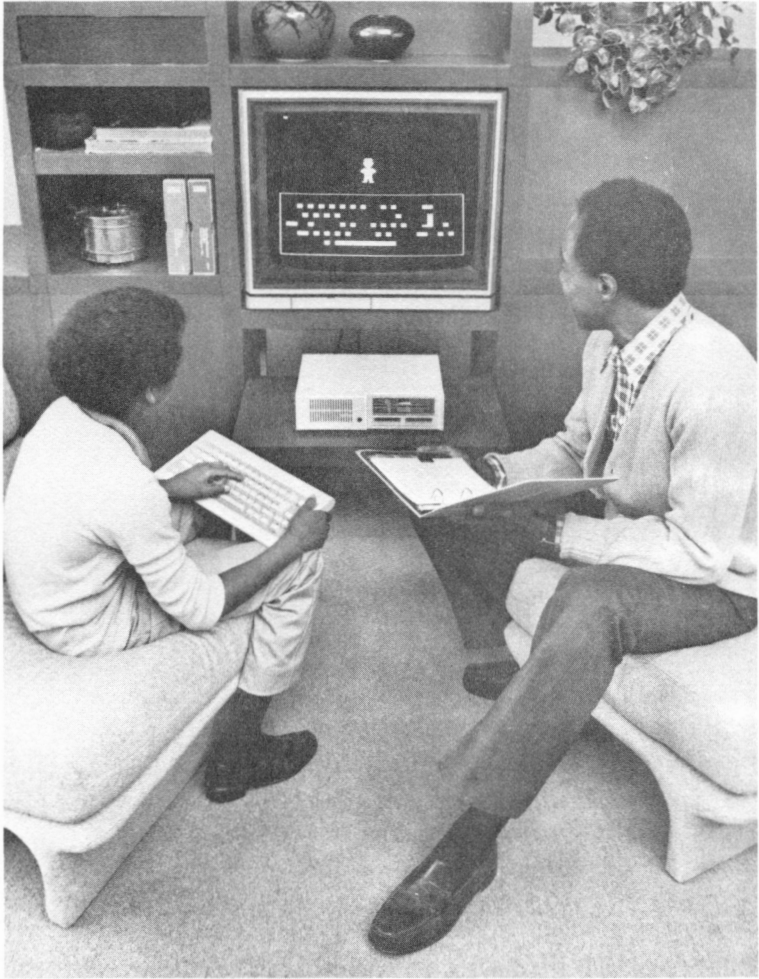
Overcoming Fear and Uncertainty

Most people who have never used computers are a little intimidated by them. That's only natural. We've been conditioned to associate computers with frightening words like error, bug, and expensive, and also with mysterious words like RAM, ROM, byte, ASCII, and algorithm. Movies and popular fiction often make computers seem bigger than life, endowing them with powers of reason and even emotions (mostly negative ones like greed, lust, hatred, and revenge). In real life, many people think computers have just three desires: to mess up telephone bills, eliminate jobs, and take over the world.

The purpose of this chapter is to tell you that "it just ain't so." If you are already familiar with computers, you probably don't need to read this chapter. But even if you do know the concepts, the analogies we use may help you explain certain terms and principles to curious friends.

What Is a Home Computer?

Computers are machines, like blenders and automobiles. To be sure, computers are very sophisticated and can do much more

than an average household appliance. But they are simply machines, which anyone can learn to use. Almost everybody does some chore that can be done better, faster, or more pleasantly with the help of a computer.

A home computer is a tool you can use for education, entertainment, and graphics. PC*jr,* for example, has software programs (we'll define this term later) that can teach children how to do math problems, play arcade games, and create complex graphics and animation. A home computer can also help you manage large amounts of information, such as writing a long letter or managing home finances.

Much as a good stereo system includes several different components, a home computer system is made up of several subsystems. Some of these components, like the keyboard, are probably familiar. Others, like the microprocessor, RAM, and software, may be completely foreign to you. As we proceed, we'll explain each of these components to you, simply at first, and then in more detail.

Defining a Few Terms

If you are new to computing, you are probably confused about all of the unfamiliar terms you've heard computer salesmen spout. This section should help you understand some of these terms better.

The Microprocessor

Even though we call the entire PC*jr* system a computer, the actual computing power of the machine is contained on one tiny silicon chip about the size of a fingernail. This chip is a microprocessor, which is called the Central Processing Unit, or CPU.

All microcomputers have CPUs. The CPU used in PC*jr* is an Intel™ 8088™: Intel is the manufacturer, and 8088 is the model number. Most CPUs have similarly odd names like MOS Technology 6502™, Zilog Z80®, and Motorola 68000™. You really don't need to know much about chips to use a computer (just as you don't have to know much about engines to drive a

car), but a little working knowledge can't hurt, so here's a brief overview.

The Intel 8088 is a 16-bit microprocessor. Great, you say—what's a bit? A *bit* is a *b*inary dig*it,* a one or a zero that is processed by the computer as a single unit of information. One means "on," and zero means "off." Computers understand only these two states of being: on or off. (Sounds rather mystical, doesn't it?)

A collection of 8 bits is called a *byte*. With all of the possible combinations of ones and zeros in 8 bits, a byte can have exactly 256 different states. Different combinations of ones and zeros are used to represent every letter of the alphabet, every number, and all the other symbols (like +, /, >, @, etc.) we use in math and writing. Each combination of bits defines a unique character, just as on a larger scale different combinations of letters make unique words in most languages. The name of the code used by PC*jr* to represent characters is ASCII. Nearly every microcomputer uses this code.

When we say that the 8088 is a 16-bit processor, we mean that it can hold and use two 8-bit bytes at one time. This means that a computer with a 16-bit processor is somewhat faster than a similar machine with an 8-bit processor. There are more important differences, but, for now, simply understand that the 8088 processor is one of the most significant features of the PC*jr* and distinguishes it from other home computers. They primarily use 8-bit chips. Because PC*jr* has a 16-bit chip, it can use a whole range of software unavailable to the older systems.

Memory

All computers have memory; in fact, most computers have two or three different kinds.

RAM

The first kind of memory is *random-access memory,* or RAM, which is sometimes also called volatile memory, main memory, or read/write memory. The computer places in RAM memory the programs and information the computer is currently using. For example, when you write a BASIC program on PC*jr,* the

program exists in RAM. Similarly, when you load a program like Multiplan into PC*jr,* that program resides in RAM. When you use Multiplan to create a financial projection, the projection is stored in a different part of RAM.

Information stored in RAM would be completely unintelligible to you and me because RAM uses thousands of tiny switches to store data. These switches are so tiny that over 64,000 of them can be squeezed onto a piece of silicon smaller than a fingernail. Each switch can be either open (on) or closed (off). The number of possible combinations that can be created from these switches being open or closed is enormous.

The size of RAM is measured in *K*. What is a "K"? It is simply an abbreviation for *kilobyte,* or a thousand bytes (actually 2^8, or 1,024 bytes). When we say a machine has 64K of RAM, we mean that it contains 64 times 1,024 bytes, or 65,536 bytes of RAM. By the way, 1,000,000 bytes (1,000K) is called a *megabyte,* which is frequently abbreviated to meg, or just M.

The laws of binary arithmetic dictate that an 8-bit computer can recognize only 64K of RAM at any one time. A 16-bit computer like PC*jr,* on the other hand, can recognize 64K times 16, or 1,048,576 bytes at a time. Programs written for 16-bit computers can be larger and more detailed than programs written for 8-bit computers. Large programs like Lotus 1-2-3™ and Context MBA™ run on only 16-bit computers.

Permanent Storage

RAM is called volatile because all information stored in RAM is lost when you turn off your computer. Some other form of storage is therefore needed to hold programs and information between computing sessions. This kind of storage is called *permanent memory.*

Nearly every home and business computer uses one of two types of devices for permanent storage: a cassette tape or a diskette. PC*jr* has the capability to use either. The enhanced PC*jr* comes with a built-in *disk drive*, the device that holds, turns, and reads diskettes. In concept, a disk drive resembles a stereo turntable. The disk drive is more expensive than a tape player. The price of

PC*jr*'s disk drive is $480, but a good tape player costs less than $100.

Although disks and tapes look substantially different, they are really very similar. Both are magnetic media. That is, they store data magnetically, just as a tape recorder stores your voice. Tapes and especially disks are very efficient storage media. For example, this entire book could be stored on just two of PC*jr*'s floppy disks (with plenty of room to spare).

The information stored on disks and tapes can be changed and erased. Thus, although we call these forms of storage permanent, they are rather flexible. A disk is like a page with pencil writing on it. The writing will remain on the page for as long as you wish. If you decide, however, to remove the writing, you can do so with an eraser. Similarly, the data stored on a disk will remain there until the information is deliberately altered or erased.

Floppy disks and tapes differ in several significant ways. The most important deals with the time required to get to information stored on the two media. On a tape, information is stored sequentially. To find particular information, you have to wind the tape forward or backward until the desired spot on the tape is located. It can take a lot of time to locate information, especially if it happens to be at the other end of the tape. On a diskette, however, information is readily accessible because of the way it is arranged on the disk. Data at any location can be retrieved quickly.

This difference between a tape and disk is like the difference between a stereo tape and a stereo record. If you want to hear your favorite song on the cassette tape, you have to advance the tape "fast forward" to get to the approximate location of the song and jockey the tape back and forth to find the song's exact beginning. But if that song is the third band on the first side of the record, you simply move the tone arm to the start of the song.

Diskettes also allow information to be transferred to and from RAM faster than tapes. In fact, information can be read from a diskette more than 200 times faster than it can be read from a tape.

For these reasons, diskettes are preferable for permanently storing information that must be accessed in a random fashion. Diskettes and disk drives are also more reliable than tapes and are, therefore, all the more favored for storing important programs. Most PC*jr*s have disk drives. If yours does not, you can still do many things with the machine, but some options will not be available.

ROM

The third kind of memory is *read-only memory,* or ROM. In a sense, ROM is a cross between RAM and permanent memory. ROM is like RAM in that both are electronic forms of memory and store information on silicon chips. But ROM, unlike RAM, is permanent memory: it does not lose its knowledge when you turn off your computer. Think of ROM as "hard wired" memory; all of the thousands of tiny switches on each chip of silicon are "fixed" in position.

Unlike floppy disks, ROM is not erasable. Once a simple ROM chip has been programmed, it can never be altered. This means that ROM is very good for storing programs and data that don't change. On the other hand, ROM is incapable of storing information that changes frequently.

ROM is usually used to store the most fundamental information required by a computer to function. For example, in many computers, ROM stores the instructions that tell the computer how to read a diskette or cassette tape. In others, including PC*jr,* ROM is used to store the computer's primary programming language. The Cassette BASIC that comes with your PC*jr* is stored on ROM, as is the Keyboard Adventure game.

The program cartridges that plug into the slots on the front of your PC*jr* contain programs in ROM. Providing ROM expansion cartridges makes the computer more flexible while keeping the use of those programs very simple. All you need to do to use Advanced Basic is plug in a cartridge.

Some Illustrations

The way you use a phone book can illustrate the difference between diskette memory and RAM memory. Do you know your

computer repairman's phone number? Let's hope not! When you need to call him, you look up his number in the telephone book, where all of the phone numbers in your city are permanently stored. When you find his number, you "learn" it temporarily—probably for only as long as it takes you to dial it. Once you make the call, the number vanishes from your mind.

In the example, the telephone book is the equivalent of the disk. The book stores telephone numbers permanently, just as a disk drive stores programs or information permanently. Reading the telephone number is similar to loading the information from the disk into the computer. Just as your brain forgets the number when you are finished with it, RAM memory "forgets" what it holds when the power is turned off.

We can also illustrate the principle of ROM using this example. Although you don't know the phone number, you don't need to learn to read to look it up. Knowledge of the language is permanently stored in your mind. In much the same way, you don't need to learn to use the phone each time you make a call. This, too, is a part of your fixed memory.

Another illustration of the difference between disk and RAM memory is the use of a library. Suppose you are an engineer who needs to perform a complex calculation. You don't remember the exact formula required to perform the calculation, so you go to a library and find a book that contains the formula. The book is like a disk. The formula is permanently stored in the book. When you read it, the formula is transferred to your brain. The process of "learning" the formula is equivalent to loading a program from the disk into the computer's RAM memory. When you read the formula, it does not disappear from the book; the formula remains there permanently but is transferred to your mind temporarily. You will forget the formula when you finish using it and go on to your next task. Even if you need to use the formula tomorrow, you will need to look it up again. In much the same way, your computer's RAM memory "forgets" programs when you give it a new task.

Can you figure out where ROM memory fits into this example? When you pick up the book to read the formula, do you need to learn to read? Of course not. Knowledge of the language is

permanent. Similarly, when you perform the calculation, do you need to learn mathematics? No. Your ability to do these things already exists and is similar to your computer's ROM memory.

There are, however, important differences between the human brain's "permanent" memory and ROM. For example, nothing prevents you from memorizing more facts about a given topic. If you don't know a word, you can learn it easily enough. After it is learned, it can become a part of your permanent memory. Your computer's ROM memory cannot be enhanced that way. Once your PC*jr*'s ROM is programmed, it is fixed for good.

Don't interpret either of the analogies above too strictly. Differences abound between the human mind and a computer. But the analogies are helpful for understanding the basic differences between the various kinds of computer memory.

Hardware

All of these components taken together—the CPU, the RAM, the ROM (and the box that holds them), and the disk drive, together with the keyboard, the monitor, and the printer (explained below)—are called hardware.

Like people, computers need ways to communicate. Think of the different ways you communicate with other people—through speech, writing, and body language, to name just a few. Most computers can't speak (at least not yet), but all computers have components that allow them to communicate with people and other computers. The hardware that computers use to communicate we call input/output devices because they channel information into and out of computers.

Wouldn't it be nice to be able to speak to your computer and have it speak back to you? Unfortunately, the technology that would allow this to happen is not yet available. When you want to "talk" to a computer, you must use a keyboard. Although keyboards are old-fashioned and very slow in comparison with the speed of the computer, they are easy to use (for most people) and inexpensive.

When you want to "listen" to your computer, you must use your eyes. Computers speak through special television sets called video displays or *monitors*. Many computers, including PC*jr*, can use

an ordinary TV set for a video display. Others require a special monitor, like the IBM Color Monitor.

The computer's other "voice" is the printer. As you probably know, printers make a permanent copy of computer output. In this respect, a printer is to the video display what written language is to speech.

Software

Like all machines, a computer will almost always do what you make it do. Given the right instructions, a computer like PCjr is capable of performing a wide range of tasks. And, as with all other machines, the operator controls the computer—not vice versa. Computers don't talk back, especially after the power plug is pulled from the wall.

The most important first step in making sure a computer will do something for you is to be certain that you know what you want done. Ponder this before you buy your computer.

If you are thinking, "I don't even know what a computer can do, much less what I want it to do!"—read on. A large part of this book is devoted to teaching you what you can do with a computer like PCjr.

Systems Software vs. Applications Software

Software is the name we give to the instructions that tell our expensive combination of CPU, RAM, ROM, and disk drive what to do. There are two main kinds of software for micro-computers: system software and applications software. *System software* includes the instructions in your computer's ROM, the computer's disk operating system (DOS), and programming languages like BASIC. *Applications software* is the programming that makes the computer do what you want it to do, such as add two numbers together or perform word processing.

System software is used to create and run applications software. For example, the BASIC programming language is system software, but a program you write with BASIC is an application.

There are many different kinds of applications software. Applications for home computers like PC*jr* may be divided into three categories: home management, education, and entertainment. In chapters 6, 7, and 8, we'll examine PC*jr*'s applications software in some detail.

Stereo records and tapes can be used again to explain—this time—the role of applications software. A stereo system is incapable of making music until you put a record on the turntable or a tape in the cassette player. When you do either, the stereo system suddenly becomes a music machine.

Similarly, a computer is utterly useless without software. About the only application for such an orphan is as a boat anchor. But with software the computer becomes useful. For example, when you load word-processing software into a computer, the computer becomes a word-processing machine.

People get confused about computers because they are so flexible and fast. As we have seen, a computer with the right software can perform a wide variety of tasks. But just because a computer can do many things does not mean it can do anything it wants at any time; that myth is a product of Hollywood. Every computer—even large computers—is always bound by its software.

Selecting Software

After you have decided what you want your computer to do, you are ready to go shopping for your computer system. At this point you are really shopping for software. Look for programs that meet your needs as closely as possible.

Going back to the stereo analogy, consider this: When you shop for a stereo, do you worry about whether it will play a certain record? Of course not. Nearly every stereo will play every record (except for a few of the new digital records). The same is *not* true of computers. Different types of computers use different types of software. Programs that will run on one computer are useless to another.

When you marry a computer, you marry its software. Some hot little arcade game from another computer brand may tempt you, but you must remain faithful to your computer. The moral?

Choose a computer that offers a wide range of interesting software. Because IBM has designed PC*jr*'s software library to be very broad, you are likely to find programs for PC*jr* that will meet your needs.

The responsibility for making the computer do what you want ultimately rests with you. You must select the tools for the desired tasks. There can be a world of difference between what you want a computer to do for you and what you tell it to do. If you choose the wrong software, the computer won't perform correctly. Buying a computer with the wrong software is like trying to run an engine with the wrong fuel. You wouldn't try to run an electric motor with gasoline, would you?

Choosing the appropriate software is the biggest challenge for all computer users. This book should help you make good choices. If you need more information, hundreds of other books about computers offer valuable advice. Magazines are another source of information, and computer dealers and users will also be helpful. Don't be afraid to ask questions.

A Few Questions (With Answers)

Now that we've developed a computer vocabulary, let's deal with some of the more common questions first-time computer users ask.

Can I Learn to Use a Computer?

Without a doubt, yes. Computers are being used today by four-year-old children and eighty-year-old great-grandparents, assembly line workers and company presidents, high school dropouts and Ph.D.'s. Computers are used by college-trained people who use them for a living and by people who, six months ago, never imagined they might be computer users.

If all of these diverse individuals can use computers, there is no doubt that you can as well. You don't have to be a systems analyst with an M.S. in computer science or a programmer to use a home

computer, although you may want to use your computer to learn to program.

Learning to use a home computer is far simpler than learning to use a large system. There are many characteristics of large computers that have nothing to do with home computers. Think of the relationship this way: you don't have to be a race car driver or an experienced 18-wheel trucker to drive a car, do you?

Can I Break the Computer?

Not by using it. It is possible to break a computer by lifting it as high as you can and dropping it on the floor, or by pouring coffee into its innards, but *it is virtually impossible to do any serious damage to your computer by using it.* Typing a wrong set of keystrokes will never cause your computer to begin smoking, or make the video monitor give up the ghost. There is no magic self-destruct feature in any computer, except the ones you see in the movies and on TV.

(Sometimes I think the people who write TV and movie scripts have never seen a computer. I saw a movie the other night that featured a computer. It had not only a personal relationship with its very attractive operator, but also the noisiest screen I have ever seen. Every time information was displayed on the video monitor, the computer made the sound of a teletype terminal!)

It *is* possible to disrupt the operation of your computer by typing a few inadvertent keystrokes. You can even lose some information you've stored on diskettes. But these errors can be easily protected against and recovered from by following a few simple rules, which we'll explain later in the book.

Will It Break Down?

In a word, maybe. Like all machines, computers break down occasionally. Because computers have relatively few moving parts, they are not subject to the same kinds of mechanical failures that occur in automobiles. Computer malfunctions are often due to seemingly insignificant problems like dust or overheating.

The odds are good that you will have very few serious problems (problems that require repair) with your computer. If you are going to have a problem, it is likely to develop in the first few hours of using the computer. The chances are that if your computer survives its first few hours out of the box, it will work without trouble for a long time. Many, if not most, computer repairs are made on relatively new machines. The repair simply corrects some small problem that came with the computer from the factory.

The components of your computer system that are most likely to break down are the mechanical parts: the disk drive, the keyboard, and the printer (if you have one). Unlike the electronic parts of your computer, these mechanical parts eventually wear out, just as toasters and transmissions do.

You can do a couple of things to help prevent a breakdown. First, handle your computer carefully. When you move it, be gentle. Although computers are fairly durable, they are also sensitive and expensive instruments. Careful handling is simply good common sense. Second, don't expose your computer to unnecessary risks. Don't park your coffee cup on the System Unit. Don't use the keyboard as an ashtray substitute or try to take the keyboard with you into the shower. Don't leave the machine where it will be exposed to extremes of heat or cold.

How Can I Get My Computer Fixed?

By taking it to a computer repair shop. It may surprise you to know that most computers are as easy to repair as a TV set and are certainly much easier to fix than a car. Computers are easy to fix because they are typically designed to be modular. If a part stops functioning, you simply replace the part with a new one. In addition, computers have almost no moving parts.

If your PCjr does break down, you can get it repaired at no charge for one year under IBM's innovative new warranty. Even better, IBM has a "swap-only" repair policy: the dealer will simply swap a new part for the broken part while you wait.

Prior to PC*jr,* most home computers (in fact, most computers of every kind) offered only a 90-day warranty. IBM's one-year

warranty is a major step forward in computer consumer protection.

You can get service for your PC*jr* at the dealer that sold you the computer or at any other IBM authorized dealer, including all IBM Product Centers, all ComputerLand stores, Entre Computer Centers, Sears Business Systems Centers, and so on.

Will a Computer Raise My Electricity Bills?

Don't laugh—one of the authors of this book asked that question not too many years ago when he was buying his first computer. The answer is no. A computer uses far less electricity than your refrigerator. In fact, a standard 100-watt light bulb uses more electricity than your PC*jr*.

Computers Are for Everybody

One of the main reasons why people are intimidated by computers is that they have no experience with them and don't understand them. If you decide to buy a PC*jr*, you'll probably think back someday and wonder how you could have been so confused. That may not be much comfort for now, but don't worry—you're already on your way to becoming a computer user. Read on and put your new knowledge to work by learning more about PC*jr*.

An Overview

Just over two years ago—in August of 1981—IBM introduced its first microcomputer, the IBM Personal Computer. In the two years since then, the IBM PC has completely changed the character of the microcomputer marketplace. The IBM PC has become the industry-standard business microcomputer.

Even before the first units of the machine were shipped, the excitement began to build over IBM's entry into the micro-computer world. Mike Markkula, then president of Apple Computer, said the announcement was "the legitimizing of the microcomputer industry." Apple placed full-page ads in *The Wall Street Journal* that said, "Welcome, IBM."

Most industry observers knew that the IBM Personal Computer would be important. Nevertheless, almost everyone underestimated the dramatic success of the IBM PC. Apparently, even IBM underestimated the potential of its product. In August, 1981, Future Computing, a consulting firm in Dallas, Texas, predicted that the PC would generate $1 billion in sales by the end of 1984. In fact, that mark was achieved before the end of 1983! Estimates of the number of installed IBM PCs vary, but many insiders expect the number to reach 500,000 easily by the end of 1983.

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A Look at IBM

IBM is a giant. The company's gross sales in 1982 exceeded $29 billion, earning it a place among the top ten U.S. corporate giants. IBM's *profit after taxes* in 1982 was nearly $6 billion, which is greater than the *gross* sales of any other company in the microcomputer industry. The second largest computer company, Digital Equipment Corporation, had 1982 total sales of only(!) $4 billion. The largest microcomputer company, Apple, had 1982 sales of less than $1 billion.

Partly because of its tremendous financial resources and partly because of its well-oiled business machinery, IBM is a strong competitor in the markets in which it participates. IBM owns the lion's share (according to some sources as much as 70%) of the mainframe computer market. In a little more than two years, IBM has claimed a nearly 30% share of the desktop micro-computer market.

IBM's Personal Computer

Before the IBM PC was introduced in 1981, many industry experts predicted that IBM was too slow and too conservative to enter the personal computer market. After all, these pros argued, a PC could never account for more than an insignificant part of IBM's total revenues. Moreover, they claimed that IBM lacked the marketing skill to sell a consumer product like a personal computer. They wondered how the PC would be sold, what kinds of software would be available for it, and how it would compete with products of such established industry giants as Apple and Radio Shack.

In many ways, the Personal Computer represented a major departure for IBM from its traditional business policies. IBM has always had a reputation for not being interested in products developed by third-party manufacturers for IBM computers. In the case of the PC, however, IBM recognized two crucial factors: it was entering a marketplace that had already developed some important standards, and the success of the IBM Personal Computer would depend on IBM's accepting some of those standards.
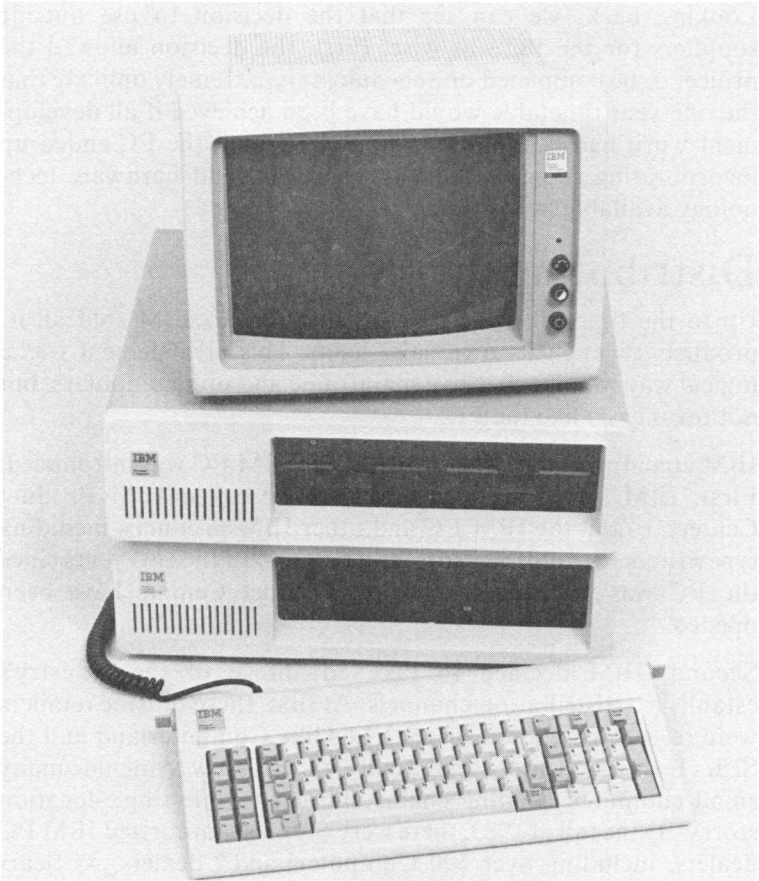
The IBM Personal Computer. (Photo courtesy of International Business Machines Corporation.)

This need to adopt accepted standards led IBM to turn to outside sources for many of the components of the PC system. The computer's operating system was developed by Microsoft, a large microcomputer software house. Among the first applications packages for the new PC was VisiCalc, already popular on the Apple II and TRS-80® computers. Even some of the PC's hardware was obtained from outside sources. The computer's disk drives, for example, are manufactured for IBM by Tandon.

Looking back, we can see that the decision to use outside suppliers for the PC was wise. First, the decision allowed the project to be completed on schedule. It is extremely unlikely that the one-year timetable would have been achieved if all development work had been done in-house. Second, the PC ended up incorporating some of the finest software and hardware technology available at the time.

Distributing the PC

Up to the time the IBM PC was introduced, IBM sold all its products through its own sales team. This arrangement was a logical way to sell expensive mainframe and minicomputers, but not for micros like the PC.

IBM abandoned this strategy when the IBM PC was introduced. First, IBM set up its own retail stores, called IBM Product Centers, to sell the IBM PC and other IBM products, including typewriters, word processors, and copiers. In the two years since the PC was introduced, over 40 Product Centers have been opened.

Second, IBM decided to take advantage of the industry's established distribution channels. At first, these outside retailers were restricted to a few large chains like Computerland and the Sears Business Centers. Eventually, the list grew to include many small computer retailing chains and even some single-location stores. By the fall of 1983, there were over 800 authorized IBM PC dealers, including over 500 ComputerLand® dealers, 45 Sears Business Systems Centers, 40 IBM Product Centers, and more than 300 independent retailers. From the beginning, IBM maintained a high standard for its outside dealers. In fact, it took IBM longer to develop its distribution system than to develop the computer itself.

The Impact of the IBM PC

The IBM PC has been tremendously successful—so successful, in fact, that an entire industry of hardware manufacturers, software vendors, book and magazine publishers, and consultants has sprung up around the machine. Retail computer stores that don't offer the PC are at a distinct disadvantage.

The PC has even begun the long-predicted "shakeout" of computer manufacturers. Osborne Computer Corporation has filed for Chapter 11, and other manufacturers, like Victor Technologies and Vector Graphics, are feeling the heat.

Enter PCjr

Many industry experts have been predicting that, after conquering the desktop computer marketplace, the next logical step for IBM would be to introduce a home computer. IBM's success in the microcomputer industry has been so overwhelming that most experts have been expecting the PCjr for many months.

The Rumor Mill

The PCjr has been the subject of rumors and predictions more than any other computer in the history of the microcomputer industry. The predictions began almost as soon as the original IBM PC was introduced in 1981, and there were nearly as many different predictions for the "Peanut" as there were predictors.

Those "experts" who predicted problems for IBM with the PC have been a bit wiser in their PCjr predictions. Most of those involved in the microcomputer industry, from consultants to investors, have been expecting the PCjr to shake up the home computer market.

Some of the characteristics of the machine were fairly easy to predict. Most observers thought that PCjr would use an Intel 8088 or 80188 microprocessor as its "brain" and run much or most of the software available for its older brother, the IBM PC, especially PC DOS and IBM BASIC.

Other factors were harder to predict. Would PCjr offer expansion slots? Would it include slots for game cartridges? Would it include a disk drive? Was PCjr one machine or several offering a variety of different combinations of features?

Even the name of the machine was not clear until the week before its introduction. The machine was known as Peanut for most of its preintroduction life, but the names Popcorn, Crackerjack, and HC (for Home Computer) were also bandied about.

In September, 1983, David Bunnell, editor of *PC* magazine, predicted that the Peanut would be a 64K color graphics machine with two standard expansion slots (like those available on the PC), DOS 2.0 and IBM BASIC on ROM chips, and Digital Research's DR LOGO™. He predicted that PC*jr* would retail for about $600. Bunnell's guess was rather close, but like all predictors he missed a few points. (By the way, it is possible that he and others deliberately toned down the accuracy of their reports to avoid causing problems for their sources or employers.)

Even *The Wall Street Journal* and *The New York Times* took a gamble at predictions. In August, in an article written by Susan Chace, *The Wall Street Journal* predicted that the Peanut would feature a built-in disk drive and a keyboard connected to the System Unit by a cord. The estimated price of this unit was $700. They thought also that the price of a system including a printer would be $1,300. Although they missed the mark on these points, they did predict that PC*jr* would be able to use "most of the programs that currently run on the IBM Personal Computer."

The New York Times also took a stab at saying what PC*jr* would be. They predicted a "$600 to $1000 scaled-down version of the IBM PC." Like most other observers, the *Times* pictured 64K of RAM and a single disk drive and assumed that PC*jr* would be compatible with the IBM PC. The *Times* was the only source to guess a cordless, infrared keyboard.

Probably the hardest thing to predict was the actual date the PC*jr* would be introduced. Early estimates said the machine would have its debut on September 15. That date later slipped to October 1, then October 15, and finally November 1 (the actual introduction date). Many people thought that IBM would ship PC*jr* the very day it was announced. There were rumors that a batch of 15,000 machines would be shipped on the day before the introduction and would be on retail floors when the product was announced. *The Wall Street Journal* predicted that about 90,000 units would be shipped before December 31, 1983.

Some experts went so far as to claim that the Peanut might not exist. These observers argued that such a computer would simply cause IBM to compete against itself since over 20% of the IBM

PCs sold were going into homes. Other experts decided that the Peanut was simply a marketing mirage, cooked up by IBM public relations pros to promote the spread of FUD (fear, uncertainty, and doubt) among rival home computer manufacturers. One industry analyst, John Kiefer of InfoCorp, said of the rumors, "If I had a dime for every rumor I heard about Peanut, I could retire."

Although most of the guessers more or less identified the hardware characteristics of PC*jr,* no one hit the nail on the head. This failure is a tribute to the secrecy of IBM. PC*jr* was in production for over six months and was only days away from introduction when the first reliable leaks occurred.

IBM took elaborate precautions to shield the machine from prying eyes. Those who viewed the machine early saw the computer in disassembled form in a temporary enclosure. In order to make any leaks easy to trace, IBM used different code names for the machine with different vendors. The computer was variously known as Peanut, Hercules, Sprite, Pigeon, and Pancake—but never as PC*jr,* its real name.

The Value of the Rumors

There is no way to estimate the value of all the preannouncement publicity to IBM. Even with its enormous resources, IBM could not have purchased enough advertising to create excitement equal to this relatively free preannouncement publicity.

IBM seemed to enjoy being the center of attention in the home computer marketplace—without the effort of announcing, producing, and shipping a home computer. At the IBM PC Fair in San Francisco in August, 1983, Don Estridge, head of IBM's Entry Level Systems Division, responded to the rumors by saying, "Even though our booth is not near the food stands, I have been constantly asked about popcorn, peanuts, and cracker-jacks." After this, Estridge would say no more, leaving Peanut watchers still in the dark.

The rumors surrounding PC*jr* had an almost paralyzing effect on the industry. Many computer dealers, including those selling IBM PCs, complained that the impact of prerelease publicity on

the market was more negative than positive. Sales of home computers manufactured by other companies slowed substantially, and the stock prices of those companies declined as the market awaited PC*jr*.

In fact, the speculation about PC*jr* was so feverish that many customers simply insisted on buying the machine—even though the PC*jr* had not yet been announced and was, in fact, repeatedly denied by IBM. One dealer in Massachusetts took over 12 orders for PC*jr* before the machine was released. He had inquiries from 50 to 60 other potential buyers. Another dealer, Computerworks in Westport, Connecticut, accepted a dozen or so nonrefundable deposits for the machine from customers who "had to have" a PC*jr*!

Most observers fully expect IBM's performance in the mainframe and desktop market to be duplicated in the home computer market. The rumored PC*jr* introduction ad budget is $75 million. Prior to PC*jr*'s introduction, *ISO World* magazine published a story by Susan Carlson predicting that the computer would capture 20% of the home computer market the first year with 150,000 computers sold in 1983, and nearly a third of the market in 1984 with sales of over a million units.

What Is PC*jr*?

PC*jr* is one of the most advanced home computers available today. Among the first home computers to use a 16-bit microprocessor, PC*jr* is also the first to be at least partially compatible with the IBM PC. PC*jr* is, in fact, two computers: an entry system, which sells for $669; and an enhanced version, which has a price of $1,269.

Entry Level PC*jr*

The entry level PC*jr* offers 64K of RAM memory, two plug-in program cartridge slots, and a keyboard. The entry system is designed to be used with a home television. This low-end machine includes Cassette BASIC, which is stored in ROM.

The plastic box that holds the computer's CPU, RAM, ROM, and expansion adapters is called the System Unit. It also contains

the two program cartridge slots. As one of the features that distinguish PC*jr* from its older brother, the IBM PC, these slots give PC*jr* the ability to use cartridge-based software. In fact, PC*jr*'s enhanced BASIC is distributed on cartridges, as are many of the machine's entertainment programs.

PC*jr* uses a unique type of keyboard. In older home computers like the Apple II, the keyboard is an integral part of the main unit. On newer machines, the keyboard is connected to the main unit by a cable; for example, the keyboard of the IBM PC is attached to the System Unit by a curly cable.

PC*jr*'s keyboard can be connected to the System Unit in a similar fashion but does not have to be. PC*jr*'s keyboard can communicate with the System Unit by means of an infrared (IR) optical link. As a result, the keyboard can be used anywhere within 20 feet of the computer, as long as the user is in front of the computer. This means, for example, that the PC*jr* System Unit can be stored in a TV cabinet or home entertainment center and used by someone sitting on the sofa in front of the television set.

The entry level PC*jr* is a good system for someone who wants an IBM computer but has a tight budget, especially if the primary application for the computer will be entertainment and simple programming. However, the entry system, having only 64K of RAM and no disk drive, cannot use much of PC*jr*'s advanced software.

The entry version is also a good system for schools. Much of PC*jr*'s educational software is on cartridges, so a disk drive is not needed. Because the BASIC programming comes with the PC*jr* entry system, it is appropriate for simple programming tasks. The price is favorable, too, especially to school districts that have tight budgets and yet want to get into computing,

Enhanced PC*jr*

The enhanced PC*jr* is basically the same computer but includes a disk drive (contained in the System Unit) and 64K of additional RAM memory. The enhanced version also offers an interface card that allows the computer to use a color monitor (instead of a TV set) and display 80 characters of text.

These additions make the enhanced computer a much more flexible machine than the entry level PC*jr*. For example, because it has a disk drive, the enhanced machine can read diskettes created by an IBM PC. The owner can create a diskette at the office and then bring that diskette home for the evening and use it on PC*jr*.

The drives available for PC*jr* are called *half-height* drives because they are only half as tall as the drives included with the IBM PC. Although the PC*jr*'s drives look different from those used by the PC, both are functionally identical. Diskettes created on either computer can be read by the other. PC*jr* is the first home computer to use half-height disk drives. These slim disk drives help make the PC*jr* a compact computer.

The additional memory in the advanced unit makes this version of PC*jr* much more practical than the entry machine. For reasons we'll develop more fully later in the book, a PC*jr* with 64K of RAM offers surprisingly little free space for programs and information.

You can expand the entry system into an enhanced system by adding a 64K Memory and Display Option card and a disk drive, but if you take this route, you'll end up spending an extra $20. We suppose that IBM wanted to build an incentive for buyers to purchase the enhanced system at the outset.

Expansion Hardware for PC*jr*

Even the enhanced PC*jr* has room for expansion. IBM has made many optional hardware devices available for PC*jr*. These include printers, modems, and video displays. PC*jr*'s hardware and expansion options are covered in detail in Chapter 3.

Printers

The PC*jr* can use several of IBM's Personal Computer printers; and a new printer, the IBM PC Compact Printer, has been introduced especially for PC*jr*. This low-cost ($170) thermal-style printer offers most of the features needed for light home use.

Those with heavy needs can buy an IBM Graphics Printer or even a NEC Spinwriter™ 3550 letter-quality printer for PC*jr*. These

printers are more expensive than the Compact Printer, but they offer great capabilities. The Graphics Printer (retail price: $595) is fast—nearly twice as fast as the Compact Printer. The NEC 3550 is a letter-quality printer capable of producing typewriter-quality print; but at $2,290, the 3550 would more than double the price of a PC*jr* system. An IBM PC*jr* Parallel Printer Attachment, which adds another $99 to the cost, is required in order to use either the Graphics Printer or the NEC 3550 with PC*jr*.

Modems

IBM also offers several modems for PC*jr*. One, the IBM PC*jr* Internal Modem, was designed especially for PC*jr*. As its name implies, the Internal Modem fits inside the PC*jr* system unit in a special adapter. The Internal Modem offers all of the capabilities required by a microcomputer modem. At $199, the Internal Modem is an excellent buy.

IBM has also made the popular Hayes® family of modems—the Hayes Smartmodems™ 300 and 1200—available for PC*jr*. The Hayes 300 is the most popular modem available for personal computers, and the Hayes 1200 is a faster version of the 300.

Color Display

When PC*jr* is equipped with the optional 64K Memory and Display Option card, the machine can use the IBM Color Display, an advanced RGB (red-green-blue) color monitor. This option retails for $680 and can be used only with a PC*jr* that has the 64K Memory and Display Option card (standard on the enhanced PC*jr*).

PC*jr*'s *Software Library*

From its experience with the PC, IBM understands the importance of software to a microcomputer. PC*jr* already boasts one of the largest libraries of applications software available for a home computer.

Much of the software for PC*jr* is adapted from the IBM PC. Programs like Multiplan and pfs:Report were first published by IBM for the IBM PC. The disk operating system used by PC*jr*,

PC DOS 2.1, is a new version of the same operating system used on the IBM PC. PCjr's Cassette BASIC is very similar to the IBM PC's BASIC.

Other software has been published by IBM specifically for PCjr. This group includes most of the educational software, like Bumble Games, and entertainment software, like Crossfire. Many of these programs have been previously available for other computers. For example, the Bumble programs were already being used with Apple and Atari.

PCjr's software library breaks down into five main groups: DOS, languages, home management tools, educational programs, and entertainment software.

DOS

PCjr uses the latest version of the popular PC DOS operating system, the system used by the IBM PC and PC XT. DOS is the software that manages all PCjr's operations. Because PCjr uses the same DOS as the IBM PC, much of the software that runs on the PC will also run on PCjr. For more information on DOS, read Chapter 4.

Languages

Languages include programming languages like BASIC and Logo. BASIC is the best-known language for microcomputers. Although there are many dialects of BASIC, if you know one form of it, you can program in most of the others without too much difficulty.

The BASIC offered with PCjr is similar to that sold with the IBM PC. IBM BASIC is a derivative of the most popular BASIC dialect, Microsoft BASIC. Literally hundreds of thousands of copies of MBASIC have been sold.

PCjr's other primary language is Logo, one of the most popular new computer languages. Logo was developed at MIT as a by-product of research into artificial intelligence. The Logo language features Turtlegraphics, an easy-to-use set of graphics and drawing commands. Partly because it includes Turtlegraphics,

Logo has gained widespread acceptance as a language for children.

BASIC and Logo are explained in detail in Chapter 5, "Languages."

Personal Management

IBM has been helping businesses manage their affairs for over 50 years. It is natural, therefore, that IBM carry that attention to management into the home with PC*jr*. It offers several sophisticated programs that can be used to manage various affairs of the home.

For example, Time Manager™ keeps records of appointments and other "to do" items, and also tracks expenditures. The pfs:File program can be used to manage a whole variety of lists, from telephone records to menus to Christmas mailing lists. When used with a printer, pfs:Report will create reports from that information.

One of the most popular programs for the IBM PC, Multiplan, is also available on PC*jr*. Multiplan is an electronic spreadsheet that can be used to perform a whole variety of personal financial management tasks, including tax planning and family budgeting. Another electronic spreadsheet for PC*jr* is VisiCalc. Although it has fallen out of favor recently, it is probably the best-selling program of all time. It offers all the features needed for most kinds of financial planning with the added advantage of being easy to learn and use.

PC*jr* offers other financial management programs as well, including Home Budget, *jr,* and Dow Jones Reporter. Home Budget, *jr* is designed to help keep track of financial records. When used with Multiplan or VisiCalc, Home Budget, *jr* is a complete home-budgeting and reporting tool. When used with a modem, Dow Jones Reporter will extract financial news, including stock quotes, from the Dow Jones information network. Another telecommunications program for PC*jr* is Personal Communications Manager. PCM is an electronic mail program that makes it possible to communicate over the telephone with other PC*jr*s.

PC*jr* also offers two word-processing programs. HomeWord, a brand-new program designed to be easy to learn and use, offers many features found in advanced word processors. EasyWriter 1.15 is a new version of the popular EasyWriter program. EasyWriter was the first word processor for the IBM PC and continues to be a strong seller in that marketplace.

PC*jr*'s personal management software library is covered in detail in Chapter 6, "PC*jr* for Personal Management."

Education

IBM has made it clear that one of its primary objectives in introducing PC*jr* is reaching the educational marketplace. As a first step in realizing that goal, IBM has published several new educational programs for PC*jr*, for example, Bumble Games, Bumble Plot™, and Monster Math. Other programs, like Arithmetic Games One and Two, have been adapted for the IBM PC library.

Much of the educational software for PC*jr* comes from the Learning Company™, a California-based firm. The Learning Company's software has been on the market for several years for other home computers, including the Atari and the Apple II.

The Arithmetic Games programs were developed by Science Research Associates, an IBM subsidiary that specializes in educational publishing. Look for much more educational software for PC*jr* from SRA.

For more on PC*jr*'s education software, see Chapter 7.

Entertainment

As a home computer, one of PC*jr*'s primary applications is entertainment. Entertainment software falls into several different categories: arcade games, strategic simulations, adventures, and computerized versions of popular board games like chess and Othello. IBM's entertainment offerings for PC*jr* include programs from all four groups.

The PC*jr* marks IBM's first venture into publishing video arcade-type games. IBM offered only adventure and simulation games

for the IBM PC. The arcade games for PC*jr* are versions of games developed by Sierra On-line, a popular manufacturer of computer games.

PC*jr*'s educational software is covered in Chapter 8, "PC*jr* for Entertainment."

Marketing PCjr

As we have seen, when IBM introduced the IBM PC, it departed from some of its long-held sales and marketing positions. With the introduction of PC*jr*, IBM is taking an even greater step away from its traditional policies.

In the first place, PC*jr* is a new kind of product for IBM. Previously, IBM has sold almost exclusively to businesses. Even the IBM PC is primarily a business tool. PC*jr* is a consumer product in the sense that it will be sold largely to individuals instead of businesses. IBM has no doubt learned a great deal about selling to consumers by selling the IBM PC. But there are many aspects of the home computer market new to IBM. These include incredible price competition, high demands for end-user training, and repair requirements.

Another possible change will be in the way PC*jr* is distributed. Available initially only through IBM Product Centers and other IBM PC dealers, PCjr will very likely soon be sold through mass-market retailers. If IBM does choose to go this route, it is likely that IBM will avoid high-discount retailers like K Mart in favor of stores like Macy's, Penney's, and Sears. If IBM does exploit these new channels, it will have come full circle from its recent devotion to selling everything directly.

3

The Hardware

By putting excellent and flexible computing power into a small, light package, IBM has used established technology to create an innovative home/personal computer system: the PC*jr*. This chapter covers the PC*jr*'s hardware: the System Unit, the Keyboard Unit, and the Power Supply. Standard and optional attachments and connections for PC*jr*, including disk drives and cartridge slots, are also discussed.

The System Unit

The System Unit is the core of PC*jr*. The outside has the traditional light buff color of the IBM Personal Computer family. Inside are the vital parts of the system: the CPU, RAM, ROM, expansion connectors and slots, and other items. The System Unit is what makes the computer a computer.

The System Unit is small for a computer of PC*jr*'s capability. The footpad (amount of desk or tabletop space the unit covers) is about 1.1 square feet, roughly one-third of the footpad size of PC*jr*'s bigger brothers. The unit is also light. It weighs about six pounds without the disk drive, and just under nine pounds with the half-height disk drive. Because PC*jr*'s outside case is mainly plastic, it is lighter than the heavy metal case of other Personal Computer family members. The plastic version does have one

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PC*jr*'s System Unit Physical Dimensions

Width   13.9 in (354 mm)

Depth   11.4 in (290 mm)

Height   3.8 in (97 mm)

Weight   Less than 9 lbs (4 kg) with disk drive

(approx)   Less than 6 lbs (2.7 kg) without disk drive

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minor disadvantage: it is not strong enough to support a television set or video monitor.

The System Unit's bottom right front side has two horizontal slots for software cartridges. Above the slots is the space for the minifloppy disk drive. Just left of center on the front of the unit is the infrared sensor for the Keyboard Unit. The sensor and the Keyboard Unit are discussed later in this chapter.

Hidden under a panel on the right side of the machine is the connector for the I/O expansion connector, where the Printer Attachment goes. Twelve other connectors for the additional devices linked to PC*jr* are located in, and on the back of, the System Unit. Because most of the connectors are at the rear of the System Unit, its front is kept free for the infrared sensor and gives PC*jr* an uncluttered appearance. The supplementary connectors, whether in or on the back of the System Unit, can be used with a cassette recorder, optional keyboard cable, joystick, serial port, video display or television, light pens, serial devices, and other equipment.

The real key to the System Unit and to PC*jr*'s capabilities lies inside the unit. Here we find the 8088 CPU (Central Processor Unit), the read-only memory (ROM), user memory (random-access memory, or RAM), the two cartridge slots, the infrared receiver and cable connector for the Keyboard Unit, connections and circuitry for the standard RS-232 serial port, the minifloppy disk drive, joysticks, light pen, and video display.

Pictured is the enhanced PCjr System Unit with the internal, half-width minifloppy disk drive and the infrared-linked keyboard. (Photo courtesy of International Business Machines Corporation.)

Additional connectors inside the unit provide the slots for the board that provides more memory for the system and an 80-column display, the adapter for the minifloppy disk drive, and a modem.

Although the list of items is long and perhaps bewildering, each can be individually examined and explained. By studying the features or functions of each item, we can understand its contribution to the PCjr's power. We'll proceed according to the popularity or functionality of the part. Based on functionality, the logical place to start is the 8088 CPU, the "brain" of the Personal Computer family.

The CPU

The CPU, or Central Processing Unit, is the master controller. It regulates all hardware items attached to the computer and

controls all data that is processed. Traditionally, the CPU has two distinct roles in a computer system. The first role, comparable to that of a railroad switchman, is to regulate and control the flow of information in the computer system. The second is calculation. The CPU, like an accountant, can add, subtract, multiply, divide, and compare information. The power of the CPU is one of the gauges used in measuring a computer system's performance and capabilities. Many other factors affect a computer, but CPU speed and capability are prime factors. Is the CPU important? Yes. Without it, a computer would not be a computer.

Big computers use a collection of integrated circuits that function as the CPU. Separate clusters of chips handle the CPU's two roles. One set handles the control and flow of information; the other, the arithmetic functions. The math section is called the Arithmetic Logic Unit, or *ALU* for short.

In microcomputers, a single integrated circuit functions as the CPU. Unlike mainframe computers, this single chip, also called a *microprocessor,* handles both control and math. The only difference between a microprocessor and a CPU in small computers is that the one microprocessor that controls the computer system is called the CPU. In small computers with more than one microprocessor, one is the CPU, and the others act as its coworkers or *coprocessors.*

All CPUs do not talk the same software language. Their native language is called *machine language.* One way to group CPUs into families is according to the dialect of the machine language they speak. As mentioned earlier, PC*jr* uses the 8088 CPU. The 8088 is the Intel™ Corporation microprocessor used in all members of the Personal Computer family, from PC*jr* to the PC XT to the 370/XT. Intel Corporation has a family of CPUs that are *software compatible.* This means that each CPU can use the same set of instructions. The members of this family are the 8086, 8088, 80186, and 80188 CPUs, all part of a larger Intel family called the iAPX™. The iAPX 86 is the 8086, the iAPX 88 is the 8088, and the iAPX 186 and iAPX 188 are the 80186 and 80188 CPUs, respectively. The corresponding sets of names are completely interchangeable. Each of these four CPUs executes the same software. In order for PC*jr* to run most of the programs that
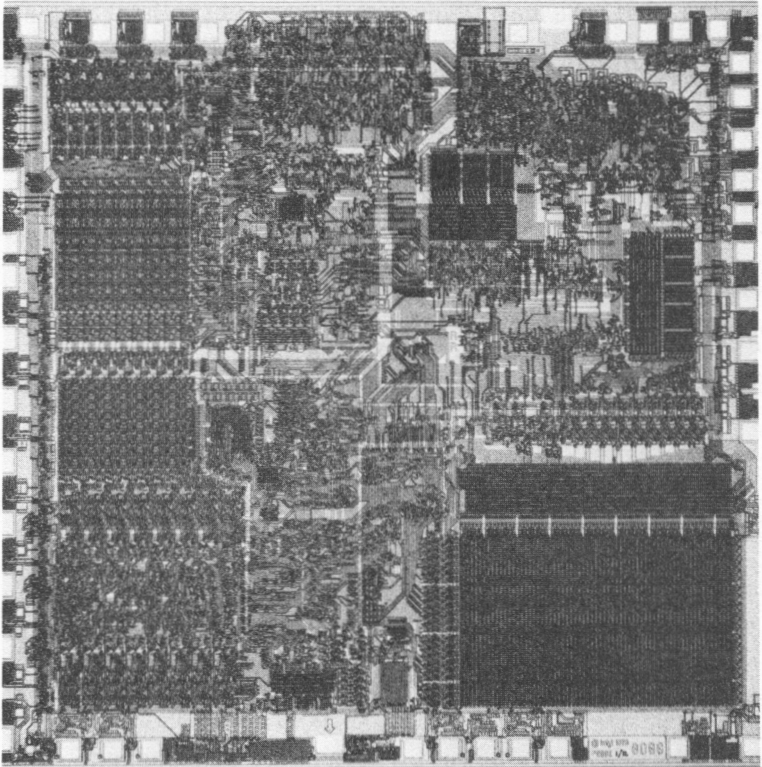
Pictured is a close-up of the silicon chip for the 8088, the CPU used in PCjr and other members of the PC family. (Photo courtesy of Intel Corporation.)

run on other members of the PC family, PCjr had to use one of these four CPUs. The choice of CPU was critical if IBM wished to maintain software compatibility. Why did IBM choose the 8088? Would another member of the Intel CPU family have been a better choice? To answer this question, we need to review some technical details covered earlier.

The basic measure of data in a computer system is a bit, or binary digit. The fundamental building block of information is a byte, or eight bits. The byte can hold a single character, or an instruction

for the CPU. The most frequent grouping of bytes in a computer is two, a total of 16 bits. (16 bits is one of the many "magic" numbers of a computer. The magic in this grouping is that 16 bits can make an integer.)

In math, an integer is a whole counting number that can be either positive, zero, or negative. In computer science, a 16-bit integer can be a whole number between either -32,768 and +32,767 or 0 and 65,535. Both ranges are frequently used in calculations. The latter range is often used when the CPU addresses (talks with) the system memory. As mentioned earlier, the 8088 is a 16-bit CPU. So are the 8086, 80186, and 80188. One advantage to 16-bit CPUs is that they can handle the math work on integer numbers quickly. Integers are the most frequently used numbers in the computer, so 16-bit CPUs can increase a computer's performance.

Earlier, we talked about the importance of expanded memory in a computer system. We'll mention the subject again later in this chapter. Meanwhile, keep in mind that having more than 64K of memory can be significant and points to another advantage of 16-bit CPUs: they can talk directly with more memory. Some 16-bit CPUs can react with over 16 million memory bytes. The 8088, as well as the 8086, 80188, and 80186 CPUs, can address one megabyte (1M) of memory. A megabyte (M) is 2^{20} or 1,048,576 bytes—more than sufficient for current personal computers.

Let's contrast the memory capabilities of the 8088 with 8-bit CPUs like the Intel 8080, Zilog Z80, or MOS Technology 6502. Most 8-bit CPUs can directly address only 65,536 bytes, or 64K, of memory. The 8088 and other similar members of this Intel family can work with 16 times the amount of memory that unaided 8-bit CPUs can. Thus, programs on computers with 16-bit CPUs can be larger, friendlier, and more productive.

There are computers with 8-bit CPUs that work with 128K or more of memory. Auxiliary circuits let the 8-bit CPU address additional banks (64K groups) of memory. The disadvantage to bank-switching is that 8-bit computers work somewhat slower than those with a 16-bit CPU. More time is needed to bank-switch than to address memory directly. If all other factors that affect a computer's performance are the same, a 16-bit CPU should

perform faster than its 8-bit counterpart when working with more than 64K of memory.

Another area of CPU power is storage and retrieval of information from the computer's memory. There is a vast difference between the 8086 and the 8088. Both can address 1M of memory; both work with 16-bit numbers in the same way. The difference lies in the amount of information each can retrieve or load into memory at one time. At any one time, the 8086 can directly store and fetch two bytes of information. The reason is that the 8086 has 16 separate data lines for the 16 different bits that enter and leave the CPU. The 8088 has 8 data lines and can talk to its memory only one byte at a time. That is why the 8088 is often called an 8-/16-bit CPU. Internally, the 8088 thinks that it is a 16-bit CPU. When communicating with its memory, the 8088 acts like an 8-bit CPU. Much of the exchange of information between the memory and the CPU takes place in groups of two bytes, or 16 bits. Then, the 8086 works more efficiently—about 25% to 40% faster than the 8088 CPU.

IBM chose the 8088 CPU for its entire current Personal Computer family, including the PC*jr*. Computers that use the 8088 rather than the more expensive 8086 can be made for less money. There is no sacrifice in performance since the 8088's speed meets the demands of most home and personal computer users.

Another CPU performance area is the system clock rate, usually calculated in millions of cycles per second or megahertz (MHz). The system clock is a timing signal used to coordinate the transfer of information among the CPU, memory, and other parts of the computer system. Generally, CPUs with faster system clock rates do more work in the same time than CPUs with slower rates. Don't confuse a regular clock with a system clock. The two have different purposes.

The system clock rate in the PC*jr*'s 8088 (and all IBM Personal Computers) is 4.77 MHz. This is slightly faster than that of most home/personal computer systems, which use the popular Z80 CPU. Most Z80s use a 4 MHz rate, although more recent systems have a rate of 6 or 8 MHz. A 4.77 MHz 8088 works marginally faster than a 4 MHz Z80. The 4.77 MHz 8088 is also faster and

more productive than computer systems like the Apple IIe and Commodore 64, which use a 1 MHz or 2 MHz 6502 CPU.

Given these factors—compatibility with the PC family, performance with 16-bit numbers, memory addressing, number of bytes stored and retrieved at one time, and system clock—how does the 8088 stack up? As the CPU is one of the factors that influences computer performance, this answer also tells us about PC*jr*'s performance.

Conclusion

The 8088, 8086, 80188, and 80186 are the only CPUs compatible with the PC family. To allow the PC*jr* to run some of the programs the PC family uses, one of these four microprocessors had to be picked. Economics made 8088 the logical choice. The 8088 offers better computative performance than an 8-bit CPU. Built-in ability to handle 16-bit numbers gives the 8088 (and the entire iAPX family) an advantage over most 8-bit processors. That the 8088 can address more than 64K of memory efficiently also separates it from the 8-bit CPUs, but the ability to address 1M of memory is what truly distinguishes the 8088. No 8-bit CPU can fetch and store more than one byte at a time, so this inability becomes a drawback only when the 8088 is compared to other 16-bit CPUs.

Since the system clock rate greatly affects CPU speed, the 4.77 MHz clock gives the 8088 a rate in between most 8-bit CPUs. Some of these CPUs can use a higher system clock rate and do more work in the same time. However, PC*jr*'s 8088 does "beat" some CPUs in system clock speed and overall performance.

The bottom line is that the 8088 performs better than the majority of home computers and is comparable to most personal computers. The 8088 also maintains an affordable price for PC*jr* and compatibility with the PC family.

Memory

Another major factor in measuring computer power is memory. Memory acts as the computer's work area, where the computer runs its programs and manipulates its data.

ROM and RAM

As you may recall, a computer has two types of memory: ROM and RAM. ROM is the acronym for read-only memory, and RAM is the acronym for random-access memory. Each type plays a different role in the computer system. A computer needs both. ROM memory is where vital, unchanging programs are placed. Volatile, reusable RAM memory temporarily holds the programs you load into the computer and the data you use.

Most computers with an 8-bit CPU devote very little space to ROM. Unaided 8-bit CPUs can address a total of 64K of memory, so the amount of ROM used reduces the availability of RAM. The 8088 CPU can address 1M of memory. The amount of space devoted to ROM therefore becomes a "nonissue." If 512K of memory were devoted to ROM, 512K of RAM would be left—eight times more than in 8-bit computer memory. Using large amounts of ROM in PC*jr* does not deny the computer 64K or more of RAM memory.

PC*jr*'s ROM

PC*jr* starts with 64K of built-in ROM. That's a memory space equal to the entire memory-addressing range of a native 8-bit microprocessor. The ROM occupies the top 64K of the 1M memory range of PC*jr* and is held in two 32 Kbits by 8-bit chips.

PC*jr*'s ROM contains seven sets of programs and some data for video display. The following routines, listed by purpose, are included:

- Power-up self-test
- Cassette BASIC interpreter
- Cassette operating system
- I/O system
- Bootstrap routine for the floppy diskette
- Diagnostic routines
- Keyboard Adventure program
- Dot pattern for the graphics video characters

The power-up self-test is a program automatically executed when the computer is turned on. The self-test checks the CPU, memory

A guided tour of PC*jr*'s Interior
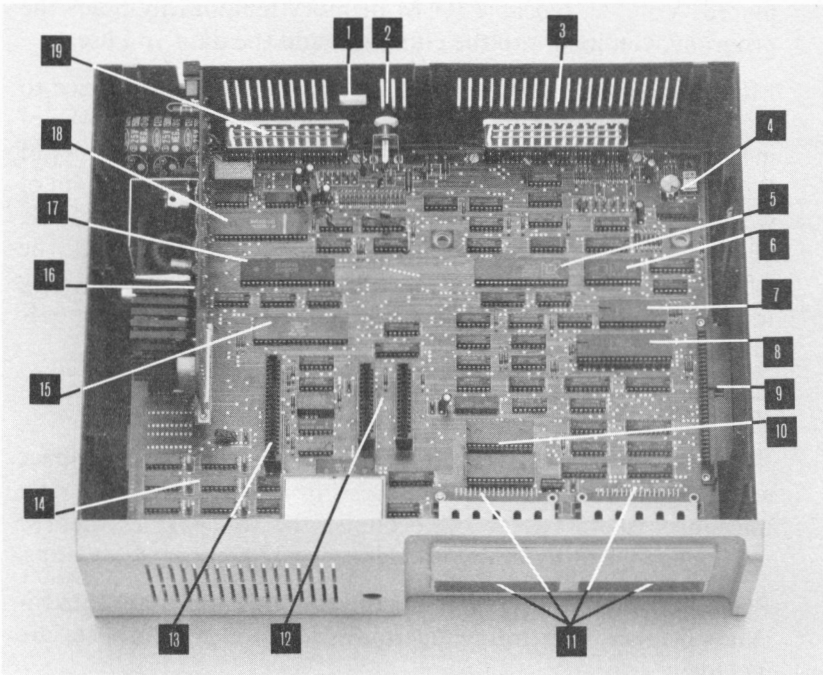
This is a picture of PC*jr exposed. The description on the opposite page tells what the major parts are and what purpose they play in PCjr. (Photo courtesy of International Business Machines Corporation.)*

1. Space for Internal Modem's modular plug and cable
2. Composite video connector
3. Connectors for (left to right):
     RF Modulator for TV
     Light pen
     Keyboard Unit cable
     Spare
     1st joystick
     2nd joystick
4. Oscillator crystal and circuitry for system clock
5. 8255A-5 Programmable Peripheral Interface chip used for I/O expansion bus
6. 8253-5 Programmable Interval Timer chip used for day-of-year, time-of-day, real-time clock, and sound generation
7. 8259A Programmable Interrupt Controller for handling interrupt requests from the keyboard, serial port, parallel port, I/O expansion bus, joysticks, and other hardware components
8. 8088 CPU
9. Two 32K ROMs that hold Cassette BASIC, the I/O System, Keyboard Adventure, power-up self-test, diagnostics, dot patterns, and other built-in programs
10. Cartridge slots and connectors
11. Infrared receiver for Keyboard Unit
12. 30-pin dedicated I/O slots for Internal Modem (left) and Diskette Adapter (right)
13. 44-pin dedicated I/O slot for 64K Memory and Display Option
14. RAM memory (two of the eight chips are not shown)
15. Special video chip
16. 6845 CRT Controller chip used for the video display
17. INS8250 Asynchronous Communications Element for serial port
18. Power regulator card (shared with disk drive)
19. Connectors for (left to right):
     Audio
     Power Cable for Transformer
     Cassette recorder
     Serial port

(ROM and RAM), and IBM attachments to the computer and ensures the proper functioning of the computer.

The Cassette BASIC Interpreter is the Microsoft BASIC-86 language. The functions and features of BASIC will be covered in the next chapter.

The cassette operating system is the software that allows PC*jr* to use an audio cassette recording to store and retrieve programs and data on cassette tapes.

The I/O System is the set of fundamental routines used by the CPU to control the devices attached to the computer and regulates the flow of information to and from these devices.

The bootstrap routine starts up the optional disk drive and attempts to load and execute the disk operating system. Disk drives are discussed later in this chapter, and DOS is discussed in the following chapter.

The diagnostic routines are a set of programs available to ensure proper working order of PC*jr* and the IBM attachments. These routines exercise and test the system more extensively than the power-up self-test.

The Keyboard Adventure, a built-in tutorial on the PC*jr*'s keyboard, is designed to acquaint new PC*jr* users on the layout, uses, and functions of the keyboard and PC*jr*.

The dot patterns are a set of data used to display the letters, numbers, punctuation, special characters, and graphics characters on the video display. The patterns are transformed by the video circuitry in the computer into the dots that make up these characters on the connected television or video monitor.

When PC*jr* is turned on, the power-up self-test runs. The video display shows the IBM logo and a pattern of 16 color bars. After the test is complete, the screen changes. If no additional cartridge or disk drive is attached, PC*jr* executes the built-in Cassette BASIC. If a disk drive or program cartridge is installed, PC*jr* attempts to start the disk drive or executes the program in the cartridge, in that order.

When Cassette BASIC is first run, hitting the special escape key on the keyboard will invoke the Keyboard Adventure. The new

user can run the tutorial and learn about the keyboard and a little about PC*jr*.

I/O is computerese shorthand for input/output. The I/O System is the set of routines used by PC*jr* to control the additional devices attached to the computer.

Each major device, from serial port to keyboard to disk drive, works and communicates with the rest of the computer in various ways. In order to use each device, the computer needs the right software routines to control the actions of the device and move data among it, the CPU, and memory.

The ROM-based I/O System provides the instructions for handling the serial port, keyboard, video display, and most other items, except the disk drives. The disk drives need their own set of software, DOS, which is covered in the next chapter.

The reason to pack so many programs into ROM is to make PC*jr* "intelligent" when you turn it on. Most of the routines in ROM are needed by the computer immediately after you turn it on. The power-up self-test, I/O System, Cassette BASIC and cassette operating system, and dot-pattern for the video display make the computer instantly functional. The disk bootstrap routine for the optional minifloppy diskette also falls in this category. If the routine were not built-in, PC*jr* could not automatically start up the disk drive.

The only routine unnecessary for starting up PC*jr* are the built-in diagnostic programs. But there is good reason to build them into the computer. With the PC and PC XT, the diagnostic set must be loaded into RAM memory from a diskette and then executed. An entry PC*jr* does not have a floppy disk. This means that the routines would need to be loaded from cassette tape, a process that could take several minutes. If anything were wrong with the cassette circuitry, the diagnostic routines could not be loaded and used. By placing the diagnostic routines in ROM, IBM has made them permanently available to the PC*jr* user. They can be run without the user having to load another program from a diskette or cassette tape. In case of possible unit malfunction, the operator can simply restart PC*jr* and run the diagnostic tests. The computer can "self-diagnose" anytime and anywhere.
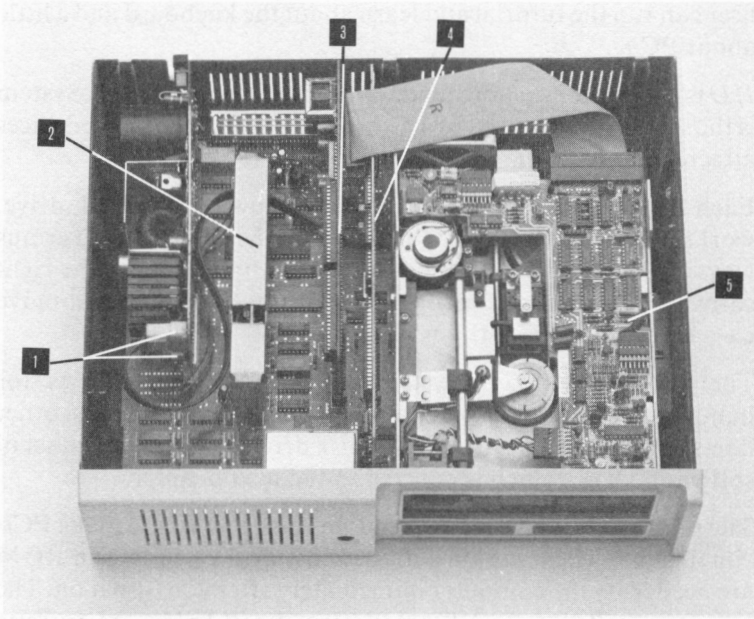
An interior picture of an enhanced PCjr with the three optional boards and disk drive mounted in the unit. Moving clockwise, 1. the two power cables for the disk drive; 2. the 64K Memory and Display Option; 3. the Internal Modem; 4. the Diskette Adapter; and 5. the half-height Diskette Drive. (Photo courtesy of International Business Machines Corporation.)

IBM has attempted to make PC*jr* a computer that is easy to use, self-contained, and self-sufficient. Because the 8088 is a 16-bit CPU, 64K of ROM can easily be devoted to holding an extensive set of built-in programs. Larger ROM space makes PC*jr* a more intelligent machine when it is started, and a more independent computer when it is used.

The Cartridge Slots

The Cartridge Slots in the front of PC*jr* are where cartridges containing ROM may be plugged in and used. The purpose of the

slots is to extend the capability of PC*jr* without consuming precious RAM space. PC*jr* cartridges are unique to PC*jr*; that is, cartridges for other home computers do not work on it. Each cartridge can hold a maximum of 32K of ROM. One such cartridge is Cartridge BASIC, the advanced BASIC for PC*jr*. Two cartridge slots are provided. This allows you to use Cartridge BASIC and one other cartridge. Although IBM offers only five cartridges for PC*jr*, outside companies will undoubtedly flood the PC*jr* market with entertainment and educational options within the next six months.

There is only one unique aspect to the slots. If you attempt to plug in or remove a cartridge while the PC*jr* is turned on, the system automatically resets itself. The reason is obvious: if you remove a cartridge that holds the program you're using, the computer has to stop executing the program. Logically, after you stop executing the cartridge program, you restart the computer system so that another cartridge can be used. When you plug in a cartridge, the most practical way for the computer to use the program is to reset the system. Because the automatic restart skips the power-up self-test, no time is spent rechecking the computer.

RAM

The RAM read/write memory distinguishes the PC*jr* from other home/personal computers and from the rest of the PC family. The entry level PC*jr* has 64K of RAM. The memory chips measure 64K by 1 bit. Eight of the chips are used to make 64K, the usual amount supplied with most home computers, like the Commodore 64, the Apple IIe, and the PC and PC XT.

Parity Checking

In parity checking we find a similarity between the PC*jr* and most home/personal computers, and a difference between PC*jr* and other members of the PC family. *Parity checking* is a constant self-testing that a computer performs on its memory. The memory chips used in PC*jr*, the PC family, and most computers are known as dynamic RAM chips, or DRAM for short. These memory chips require less power than other types, but very

occasionally they "forget" what they are holding. Such a phenomenon is called *soft drop,* which means that one bit in a memory location inside the chip changes. Soft drop occurs about once in every couple million times the CPU accesses the DRAM.

You cannot foresee when soft drop will occur, or what happens when it does. If it occurs in a memory location that is not being used, no harm is done. The next time the CPU puts something into this location, the situation will be corrected. If soft drop occurs where a program or data is stored, the results are unpredictable. The program may act erratically, freeze the computer completely, or corrupt the data. The worst that could happen is that soft drop would occur in the disk operating system and erase certain portions of a file or complete files from a diskette. Such an event, however, is highly unlikely.

To stop soft drop or other RAM hardware failure from destroying programs and data, the PC family uses parity checking. Parity checking is a way to detect soft drop or a true RAM hardware failure. When a parity error occurs, the special parity checking circuitry emits a special signal. The computer displays an error message and immediately "freezes." The only way to recover from a parity error is to turn the computer off, then on again. Everything that was held in the RAM memory is lost. This lock-up of the computer stops the processing or storing of nonsense information.

PC*jr* does not use parity checking; most home or personal computers don't. Why IBM chose to omit parity checking from PC*jr* is not clear. The cost of the circuitry, which would have increased the price, may be one reason. Some people find that locking up the computer on a parity error is annoying. Because PC*jr* is targeted to home, educational, and personal productivity uses, a parity error may not cause the same havoc as in business applications, where the data must be absolutely right.

More on Memory

Another difference between the PCs and PC*jr* is the video display and memory. We'll talk about the video display later. For now, let's discuss the video display in relation to RAM memory.

RAM has other uses besides holding programs and data. The Cassette BASIC language, for example, is located in ROM, but takes some RAM memory for itself, about 4K worth. If the optional Cartridge BASIC is used, the amount increases to 6K.

A major memory grabber is the video display. In the PC, some dedicated RAM memory is placed on the adapter for the video display while the "user" RAM memory is unaffected. PC*jr* does not have any RAM memory dedicated to the video screen. Instead, PC*jr* takes 16K from the pool of 64K or 128K of RAM in the computer. Thus, a 64K PC*jr*, without using BASIC, has 48K of free RAM memory. If you use Cassette or Cartridge BASIC, you have only 44K or 42K of memory left for programs and data, respectively. Is 48K (or 42K with BASIC) of RAM enough memory for programs and data to run? In some cases, yes. If the programs are in cartridges, 48K is more than sufficient. If the programs must be loaded into RAM memory, 48K may fall short. Although 48K provides almost as much RAM memory as is found on most 8-bit based computers, it may not be sufficient for more sophisticated programs. In these cases, additional RAM memory is essential. This is true for disk drives as well. The software to use the disk drive (DOS) takes another 24K of RAM.

Table 3.1 shows the amount of RAM memory used by the video buffers, BASICs, and DOS and the remaining memory available for your programs and data. Notice that if you try to use Cartridge BASIC and DOS, only 18K is left out of the initial 64K of RAM. 18K is not enough RAM memory to do anything useful with the computer. For this reason, IBM has a board that adds 64K to PC*jr*. That board is the topic of the next section.

The Memory and Display Expansion

The first major option for the PC*jr* is the 64K Memory and Display Expansion board. It plugs into a 44-pin dedicated expansion slot in the System Unit. The board, optional with the entry level model, but preinstalled in the enhanced unit, is one of the two differences between these models. The other difference, the disk drive, is covered later in this chapter. Unlike the other PCs, which use switches to tell the system how much memory is

Table 3.1
Memory Usage in PC*jr*

Item	RAM used	Memory free in	
		64K PC*jr*	128K PC*jr*
Video buffer	16K	48K	112K
Cassette BASIC	4K	44K	108K
Cartridge BASIC	6K	42K	106K
DOS	24K	24K	106K
Cartridge BASIC w/DOS	30K	18K	82K

Note: All totals for BASIC and DOS include the 16K for the video buffer.

mounted in the computer, the owner does not need to set any switches with PC*jr* when adding this board.

Only one Memory and Display board may be installed on PC*jr*. The metal-shell board plugs into the 44-pin slot, the only 44-pin slot in PC*jr*. Total RAM memory then reaches its maximum of 128K. PC*jr* automatically recognizes the board and uses the extra memory. If the entry model of PC*jr* is purchased, the 64K Memory and Display Board may be added at any time. Instructions are provided for installing the board and running the power-up self-test, which can recognize and diagnose problems.

A board is necessary if the PC*jr* owner wishes to exercise any of the following functions or features:

- The disk drive and DOS V2.1
- Any software requiring more than 64K of memory
- 80-character lines on the video display

The disk drive, DOS, and other software are covered later in the book.

Some implicit deductions can be made about the memory expansion board. IBM restricts PC*jr* to one, which adds 64K of RAM. The resulting 128K is far less than that of PC*jr*'s older
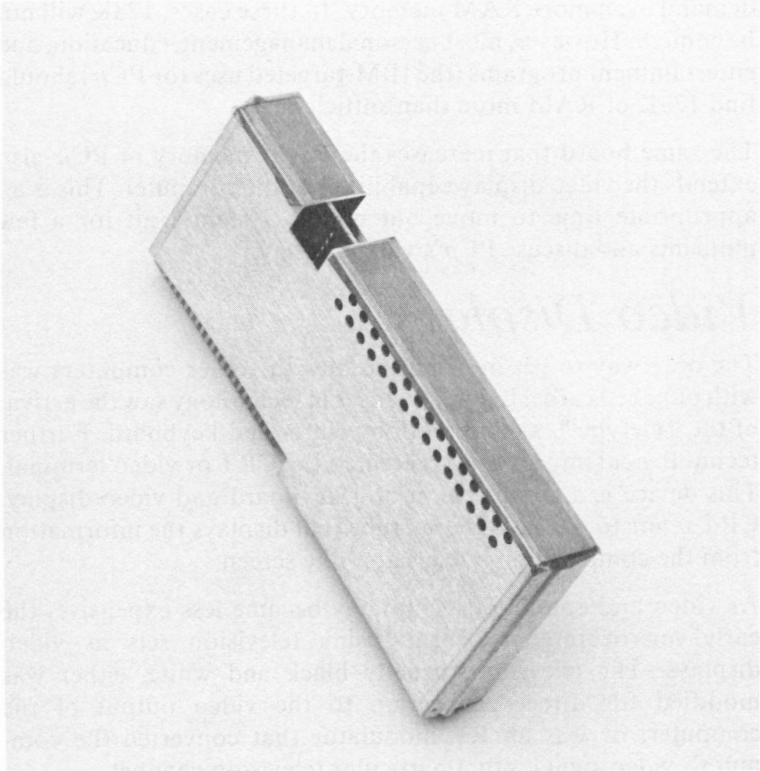
Pictured is the 64K Memory and Display Option. As the board has video circuitry that might interfere with television reception, the board's metal case blocks most possible RF interference. (Photo courtesy of International Business Machines Corporation.)

family members. The IBM board is the only one that allows PC*jr* to display 80-character lines. Whether IBM will produce a more capable RAM board is a matter of speculation. However, the current RAM expansion of PC*jr* clearly shows that IBM positions PC*jr* under its PC and PC XT.

Is 128K enough RAM memory? The answer is a qualified "maybe." 64K may be enough memory for many applications, but 128K covers even more ground. Items like electronic spreadsheets

demand even more RAM memory. In these cases, 128K will not be enough. However, most personal management, education, and entertainment programs (the IBM-targeted uses for PC*jr*) should find 128K of RAM more than sufficient.

The same board that increases the RAM memory of PC*jr* also extends the video display capabilities of the computer. This is an appropriate time to move out of the System Unit for a few moments and discuss PC*jr*'s video display.

Video Displays

The only way to get information into the older computers was with punched cards. Later, advances in technology saw the arrival of the Teletype™, a combination printer and keyboard. Further technological improvements created the CRT or video terminal. This device is a combination of a keyboard and video display. CRT refers to the cathode ray tube that displays the information from the computer on a television-like screen.

As video and computer technology became less expensive, the early microcomputers began using television sets as video displays. The television, usually black and white, either was modified for direct connection to the video output of the computer, or was an RF modulator that converted the computer's video signal into a particular television channel.

Unfortunately, the bandwidth (width of the frequency used to carry audio and video information) of a TV is limited, making lines with more than 62 characters appear smeared and illegible. Televisions cannot display lines with 80 characters per line, the standard number of characters for most computers. The maximum number of black and white characters to a television line is 62. In color, the maximum number per line drops to 40.

IBM created the PC family in order to display either 40 or 80 characters per line. The 40-characters-per-line mode was intended for use with home television sets; and the 80-character-per-line mode for black and white monitors or for high-resolution color monitors. PC*jr* follows this standard. The entry level unit only displays 40 characters per line. The enhanced model, with a board we'll discuss later, can display either 40 or 80

characters per line. The 40-character mode is ideal for a color home television set. Characters as well as some color graphics can be displayed in color, but a separate adapter is necessary to connect PC*jr* to the TV.

IBM offers an adapter that connects PC*jr* to the TV in the same way video games are connected to the set. The box is really a sealed RF modulator, which converts the composite video signal produced by the computer into a channel your TV can receive. The box (and a cable) connect PC*jr* to the VHF jack for the TV's antenna. In turn, the VHF antenna is joined to the box. You switch the box to "Computer" when using PC*jr* and back to "TV" when viewing normal TV stations. If you subscribe to cable TV services, you will probably need to purchase a "hotbox" adapter that converts the 300-ohm "twin-leads" of the box to the 75-ohm coax cable used by cable TV companies. Another switch on the box tunes the RF modulator to channel 3 or 4, like most video games and video recorders.

A TV cannot be used in place of a monitor if you want to display 80 characters on a line. You will need the 64K Memory and Display board and an appropriate monitor. A TV cannot be used in place of a monitor. Televisions are constructed to handle the broadcast channels used in the United States and Canada. Our televisions stations do not transmit a very dense (number of dots per inch) video picture. The bandwidth of television is only 5 MHz versus the traditional 7 MHz to 14 MHz of video monitors. Hence, TV picture tubes just cannot handle 80-character lines from a computer.

Choosing the right video monitor is important. You'll need to decide whether you want to use color or not. If you don't need color, almost any monochrome monitor (black and white, green and white, etc.) will work. The composite video signal that comes from the PC*jr* is not compatible with the IBM Monochrome Display used with the rest of the PC family. To connect the PC*jr* "video out" jack to the "video in" jack of the monitor, all you will need is a cable. PC*jr* uses the popular RCA "phono" connector for the composite video signal, and the cable is sold in many stores. You can purchase it at the same store where you buy your video monitor.

If you do want color, most color video monitors will only work with the 40-column mode. As with TVs, the bandwidth of most composite color video monitors cannot handle 80-character lines or the higher-resolution color graphics modes of the PC*jr*. (These graphics modes will be discussed in the chapter on BASIC.) If you want color and 80-column lines, you will need a special monitor, called an RGB monitor. The RGB stands for red, green, and blue, the three primary colors in photography. These monitors are sometimes called "direct drive." They do not use the composite video signal that regular monitors use, or the modulated television signal that RF modulators produce. RGB monitors use a separate line from the computer to the monitor to "drive" each of the three primary colors. Three more lines are used for horizontal and vertical drives and brightness (known as *intensity* in computer/video jargon). PC*jr* includes the jack for connecting an RGB monitor. An appropriate cable is also necessary.

The advantage of the RGB monitors is their vivid display of color graphics. The bandwidth of the display and the video circuitry inside the monitor make it ideal for color and graphics production. The disadvantage of these monitors is their price. A typical monochrome monitor can be purchased in the $100 to $200 range. A composite video color model runs between $200 and $1,000. An RGB monitors costs between $650 and $2,000, depending on its resolution. In the video world, *resolution* is the number of dots the picture tube can display per inch. The resolution of monochrome monitors is based on how many individual rows and columns of single dots can be lit on the screen. Color monitors use three individual dots—one red, one green, and one blue—to form a single point on the screen. For a color monitor to have the same density or same number of displayable points of light as a monochrome monitor, the color version must have three times as many dots.

Color picture tubes are more expensive to make than monochrome picture tubes. As the bandwidth of resolution increases, so does the price of the monitor. Manufacturers usually adjust the price of their color monitor according to its resolution and bandwidth. This is why most composite color models are called *medium-resolution* monitors. Their resolution is in the "average" range, and their corresponding price tag is average: $200 to $600.

Unfortunately, these monitors do not have the necessary bandwidth to display accurately 80-character lines or the two-color graphics modes of the PC family. RGB monitors, although higher in price, have sufficient resolution and bandwidth for this display.

Before IBM introduced its own reasonably priced ($680) RGB monitor, most were in the $1,000+ price range. Now, prices are declining. An IBM adapter cable must be purchased in order to connect PC*jr* to the normal cable of the IBM Color Monitor.

The impact of the monitor's price may be overlooked when considering the cost of PC*jr*. If you plan on a 40-column display and low-resolution graphics, a home television set will suffice. If you need 80-column lines and choose to forego color, a monochrome video monitor will work. This may add $100 to $200 to the starting purchase price. If you want color graphics, the RGB monitor with its adapting cable will cost an additional $700. That doubles the cost of buying an entry PC*jr*. The choice of video display plays a significant role in the decision to buy PC*jr*.

A hint on buying monitors. Before you purchase yours, unless it is the IBM Color Monitor, try PC*jr* with the monitor. Check the clarity and sharpness of the text on the screen. Run the diagnostic program and observe the medium- and high-resolution graphics on the monitor. This "test drive" of the monitor assures that it is the right choice for use with PC*jr*.

The Keyboard

One of PC*jr*'s attractions is the Keyboard Unit. It differs in three respects from those of PC*jr*'s bigger brothers. The most notable difference is that the keyboard is not physically connected to the System Unit. The far edge of the Keyboard Unit has two infrared transmitting diodes. The Keyboard Unit, powered with 4 AA-size penlight batteries, transmits the keys you type to an infrared receiver on the front of PC*jr*'s System Unit.

PC*jr* is the first home/personal computer to have a keyboard with an infrared (IR) link. This allows the System Unit to be on one side of a room while you operate the keyboard from a desk, chair,

Pictured is the entry PCjr, Keyboard Unit, and optional Keyboard Unit cable. (Photo courtesy of International Business Machines Corporation.)

or couch on the other side. The cordless use of PC*jr*'s Keyboard Unit makes the PC*jr* easy and comfortable to operate.

Three restrictions apply to this cordless use. First, the keyboard's infrared transmitters must have a clear, unobstructed "line-of-sight" to the front of the System Unit. By nature, infrared transmission is highly directional and requires this line-of-sight. Second, the keyboard must be within twenty feet of PC*jr*. In most homes, the television is seldom more than twenty feet away from a couch or chair; hence, this range is rarely a limitation. The third is that all PC*jr*'s Keyboard Units use the same infrared frequency for transmitting keystrokes to the System Unit. This means that the optional keyboard cable will be necessary if more than one PC*jr* is in the same room. If the keyboards are not connected to the computer, anyone with another Keyboard Unit could type on

any PC*jr* located within twenty feet. One of the jokes that circulated in a PC*jr* training class was that you should not announce you were playing a game well, because someone else across the room could reset your computer, using the other Keyboard Unit, and destroy your good score.

Having no more than one PC*jr* in a room is particularly important to business people and educators. In businesses, one person may inadvertently cross-type onto a different PC*jr*. A mischievous student could create chaos in a classroom full of PC*jr*s. When the optional keyboard cable is used, the infrared sensor is automatically disabled. This eliminates the possibility of cross-talk.

A potential disadvantage to the PC*jr* IR link in that other household items may use the same frequency as that of the PC*jr* Keyboard Unit. The potentially conflicting items are remote-controlled TVs, VCRs (video cassette recorders), and stereo systems. It is possible, but unlikely, that PC*jr*'s Keyboard Unit might change the channels on your TV, or your remote control might "type" on PC*jr*.

Unlike the PC and most other IBM keyboards that provide good tactile feedback when a key is pressed, PC*jr*'s keys, with their rubber top, are mushy and don't have the "feel" of a Selectric® typewriter. The keys are smaller than traditional Selectric ones, and the spaces between the keys are larger than on a normal keyboard. Touch typists may need to adjust to this keyboard. However, the large space between rubber-top keys are an advantage where children are concerned. There is little chance that their smaller fingers will overshoot and hit the wrong key, and children can easily focus their eyes on the keys because of the larger spaces between them.

Unlike the other PC keyboards, the keys have a carbon-based membrane technology. The ultimate difference is that the PC*jr* keyboard may wear out faster than other PC keyboards. How long the PC*jr* keys will last is unknown, but they should last at least two years or more with normal use.

No legends (letters, numbers, punctuation, etc.) appear on the keys, another difference between PC*jr* and other computers.

Instead, overlays are placed on the top of the keyboard. They are similar to the type used for Mattel's Intellivision in that the legends for the keys are on the overlays. IBM sells some blank ones that you can write on and use with the keyboard, if you desire.

Why are the keys unlabeled? The keys are "soft" or program controllable. The keyboard starts as a standard QWERTY, typewriter keyboard. (QWERTY refers to the six lettered keys in the upper left-hand portion of the keyboard.) However, a program can define whether any or all of the keys will type. Redefinition of what a key types through software allows you to type several letters or complete sentences through the touch of one key. As programs can redefine what each key does, IBM chooses to use overlays that will "letter" the keys.

Some small disadvantages exist in the overlay approach. If you turn the Keyboard Unit upside down as you carry it, the overlay can fall off. Also, the overlay is a separate item you will need to carry around with PC*jr* if you move it. Murphy's Law states that if you can forget something, you will, so without the overlay, it is difficult to remember what key does what. Another minor disadvantage is that if you lean back in your chair while using the keyboard, the raised keycaps can hide what is on the overlay.

The keyboard has 62 keys. Other members of the PC family use 83 keys. Which keys have been omitted or changed on PC*jr*'s keyboard? If you're familiar with the keyboard of the PC family, the following partial summary will answer that. The 10 special-function keys on the left side of the PC keyboard are gone, together with the 13-key numeric keypad on the right side and the Num Lock key. However, PC*jr* adds a separate "function" key and has four keys for cursor control. Although some keys have been removed, every one that can be typed on the PC can be typed on PC*jr*. To type some keys, such as the special-function ones, you'll need to hit two keys. To type the equivalent of the F1 function key, you hold down Function key and tap the 1 on the top row.

In summary, PC*jr*'s Keyboard Unit has exciting potential. The infrared link between it and the System Unit has appeal. The keyboard does not have a Selectric feel but is ideal for youngsters.

Although the PC*jr* keyboard has fewer keys than the PC keyboard, anything you can type on the PC can be typed on PC*jr*.

The Disk Drive

Another item that distinguishes the entry PC*jr* from the enhanced model is the minifloppy disk drive. It is a cross between a tape recorder and a record player. Like a tape recorder, the disk drive records information onto a metallic-oxide-coated disc called a diskette, which is circular and spins in the disk drive like a record. The difference between a record and a diskette is that the disk drive can record and recall information from the diskette. Unlike the tape recorder, which must access its tapes sequentially, the disk drive can rapidly skip to any section of the disk.

Floppy disk drives come in two sizes: 8-inch and 5 1/4-inch. The size is based on the diameter of the circular diskette that is inserted into the disk drive and holds the information. Technically, the 8-inch size is a floppy and the 5 1/4-inch size is a minifloppy. Since PC*jr* uses only one kind of diskette (5 1/4-inch), we'll use the term "floppy" throughout this book.

The disk drive used in PC*jr* is half-height. A regular minifloppy disk drive is about 3 1/2 inches tall; the half-height version measures 1 3/4 inches. The advantage of the latter is that it occupies less space in the System Unit. The half-height disk drive weighs just over two pounds, about half as much as a full-size drive. Functionally, there is no difference between full-sized and half-height models.

The disk drive stores 360K of information on the diskette. This is the same amount stored by the full-sized disk drives used in the PC and PC XT. Most of the remaining statistics concerning the disk drive are also identical to those in the PC and PC XT.

Disk drives are faster than tape recorders and record players for several reasons. The diskette revolves at a rate of 300 revolutions per minute, faster than record players. More information can be stored per inch than on audio records or tapes. Also, the disk drive can skip to any spot on the disk and read the information recorded there. To do this skipping, a diskette is broken down into sections. Like a phonograph record, a diskette uses a series of
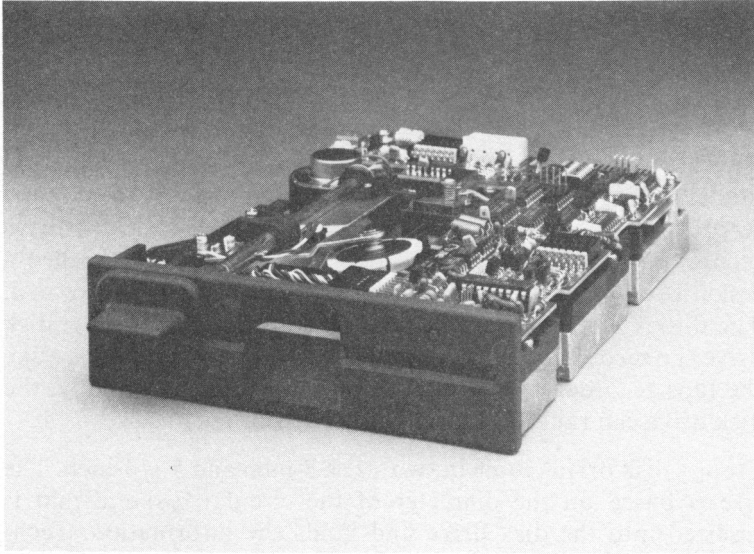
Pictured is the Qume QumeTrak 142 half-height disk drive used in PC*jr.*
(Photo courtesy of Qume Corporation, a subsidiary of ITT.)

circular bands. These recording bands are called *tracks,* forty on each side of the diskette. Every circular track is broken down into slices called *sectors,* of which there are nine on each track on both sides of the diskette.

Every sector of the diskette holds 512 bytes of information. Bytes (512) multiplied by sectors (9) by tracks (40) by sides (2) give a total of 368,640 bytes, or 360K.

The disk drive is double-sided, meaning that it can record on both sides of the floppy diskette. However, if desired, only one side of the floppy diskette can be used for recording. The PC*jr* disk drive can produce or read single-sided diskettes that are used with disk drives in the original PC.

If you purchase the entry PC*jr*, the unit can be expanded to the same size as the enhanced unit by adding the 64K Memory and

Display board and the PC*jr* Diskette Drive package. Included are the disk drive, an adapter board, a power cable, a "data" or signal cable, and an instruction board. To install the package, open the System Unit, plug the adapter board into the rightmost 30-pin expansion slot, mount the disk drive, and connect the three cables. These steps have already been done on the enhanced model.

Some other technical facts about the disk drive are worth noting. There is one major difference between the PC*jr* disk drive and those in the PC and PC XT. Unlike the PC and PC XT, the PC*jr* has recording heads in the disk drive that need to settle after they have moved between the concentric tracks. This settling period is 20 milliseconds, or 1/50 of a second. Without this time, the disk drive won't read and record information reliably. Thus, the disk drive in PC*jr* is slower. The settling time also accounts for why PC*jr* can use only DOS V2.1 We'll discuss DOS V2.1 in a later chapter.

The disk drive is much faster than a cassette tape, the other method used to store programs and data. The disk drive's data transfer rate is 250K bits per second. That's a maximum rate of 32,000 characters a second that can move between the disk drive and the CPU. The cassette recorder works at a rate of about 150 characters per second, or 213 times slower. The true data transfer rate of the disk drive, when you include the time needed for the disk drive to settle into place and find information, makes the disk drive about 125 to 160 times faster. That's why most people immediately choose to get a disk drive for their computer system. The speed and convenience of the floppy disk drive is worth the extra price.

The disk drive and how it affects your use of PC*jr* will be discussed again in Chapter 4 on DOS.

Other Items for the System Unit

The major parts of the hardware of PC*jr* are the CPU, ROM, RAM, the disk drive, the Keyboard Unit, and the video display. However, there are several other particulars built into PC*jr*, most of which we'll cover in this section. Even though the connector for

an item may be on the back of PC*jr*, you may still need an optional cable to use it. We'll mention any optional items in this section.

Cassette Recorder

IBM does not sell a cassette tape recorder for PC*jr*. IBM does sell a cable that connects PC*jr* to a cassette recorder. The cable has three connectors that plug into the Auxiliary, Earphone, and Remote jacks. The Auxiliary jack is used to record information from the computer onto the cassette tape. The Earphone wire carries information from the tape to the computer. The Remote allows the computer to pause the cassette recorder.

Which cassette recorder should you use with PC*jr*? The best ones to use with a computer are in the mid-price range, between $25 and $70 dollars. Amazingly, cassette recorders that are outstandingly good for music are not for computers. Dolby® noise reduction and other electronic filtering systems usually cannot keep up with the rapid audio frequency changes that a computer produces when it records on a cassette tape. Since the quality and features of cassette recorders vary so much, take your PC*jr* to the audio store and try out the cassette recorder. In the past, we have found that some recorders, in the same price range but from different manufacturers, do not work the same way. Some performed better, and others not at all.

Serial Port

PC*jr* has a built-in serial port. This is another difference between the PC family and PC*jr*. With the former, you must buy an optional adapter to get a serial port.

There are two ways to transmit the bits in a byte between devices. One way is to break up each byte into bits and send each one at a time. The receiving device reassembles them into a byte. The sender also includes with the byte some extra bits that tell the receiver where the beginning and ending bits are. One additional bit, called a *parity* bit, may also be sent. The parity bit is a *checksum* based on the number of binary zeros or ones in the byte. The receiver compares the byte it gets and the parity checksum. If the two don't compare correctly, the receiver knows

the character was not transmitted properly. The method of breaking a byte down and sending its bits one at a time is the *serial* method of communication. Serial communications are used with modems (devices that transmit computer information on a telephone line), printers, and other items. The appeal of serial communications is that only two to eleven wires are needed to connect two devices.

The serial port is on the back of the System Unit. A versatile National Semiconductor INS8250 chip drives the serial port. An optional 3-inch cable is sold by IBM to connect this port to a computer industry standard 25-pin "D" connector. The full computer label for the connection and electronic signal is *RS-232-C*. The connector on the end of this cable is used by most modems, printers, and other serial devices. The signal lines that PC*jr* supports are transmit data (TD), receive data (RD), request to send (RTS), clear to send (CTS), signal ground (SG), carrier detect (CD), and data terminal ready (DTR). Most devices use two or more of these signals. Few devices require more signals than PC*jr* provides, and most serial devices will work with PC*jr*.

The serial port can send or receive information at baud rates of 110, 150, 300, 600, 1200, 2400, 4800, or 9600. The *baud rate* is roughly the number of bits per second that the computer sends or receives. Since the computer uses one bit for the start of a byte and one bit to signal the end of a byte, 10 bits are usually sent for every character. If you divide the baud rate by 10, you can approximate the number of characters transmitted per second (110 baud is roughly 11 characters per second;, 300 baud, 30 characters; 1200 baud, 120 characters; and 9600 baud, 960 characters). The baud rate, as well as other characteristics of the serial port, may be controlled by DOS, BASIC, or your programs.

In order to use a modem or serial printer with PC*jr*, you'll need this cable and another cable to connect the device to the IBM cable. To complicate matters, not all serial devices use the RS-232 wires the same way. Rewiring and crossing some lines in the cable may be necessary for the device to work with PC*jr*. Our suggestion is to take PC*jr* to the dealer where you'll buy this device and try out the cables, or take your device and cables to where you'll buy PC*jr*. You'll save time and avoid troubles by having the dealer and the technical staff help you.

One last point should be made about serial printers before we move on. Some letter-quality serial printers use a set of special characters to coordinate character movement between the computer and the printer. These are called *software protocols*. PC*jr* and its disk operating system do not "know" how to handle software protocols, so some serial letter-quality printers won't work with PC*jr*. If, however, the printer functions with the PC or PC XT, it will also work with PC*jr*.

IBM Compact Printer

One of the products introduced with PC*jr* is the IBM Compact Printer. The Compact Printer is an inexpensive ($175) hard copy device that attaches to the serial port of PC*jr* or other PCs.

The printer uses thermal technology and treated paper to form characters or graphic images. Thermal printers use small, heated pins in a mobile printhead. The heated pins pass over the treated paper and "burn" an image onto it. Advantages of thermal printers are their low cost and noise, plus their ability to print the video screen graphics image, but in black and white only. Disadvantages of thermal printers are their slowness (50 characters per second versus the traditional 80 to 200 characters per second of other printers) and the higher cost of thermal paper compared to regular paper. In addition, thermal paper turns black with age, and information on the page can be lost.

Despite these disadvantages, the statistics on the printer are impressive. It is 3.5 inches high, 12.3 inches wide, and 8.8 inches deep, and weighs only 6.6 pounds. The weight and size are in keeping with the light compactness of PC*jr* itself.

The printer uses paper up to 8.5 inches wide. It is held and fed through the printer the same way a typewriter handles the paper. This is called platen feed.

There are modes for the printer. The number of characters per inch (CPI) and characters per line (cpl) are

- 10 CPI or 80 characters per line
- 5 CPI or 40 characters per line
- 8.75 CPI or 68 characters per line
- 17.5 CPI or 136 characters per line
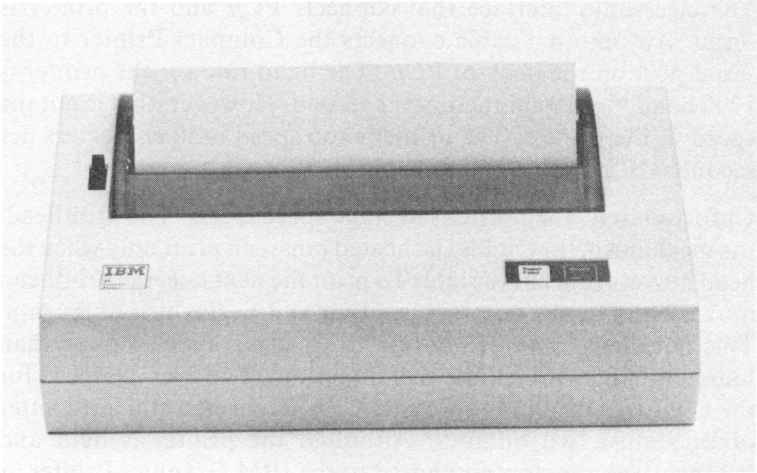
Pictured is the IBM Compact Printer. The printer heats the pins in the printing mechanism to create characters or graphic pictures on the thermal-sensitive paper. (Photo courtesy of International Business Machines Corporation.)

The size of the characters varies with the number of characters printed per inch. Character printed at 5 CPI are twice as large as those printed at 10 CPI and over three times larger than characters printed at 17.5 CPI.

Small characters in the 17.5 mode are best for printing spreadsheets, in which a large number of characters must often be able to fit on one line.

The printer can print lines of characters compressed at 6 or 9 lines per inch.

The Compact Printer can print any character that appears on the PC*jr*, including graphic characters. Don't confuse graphics with graphic characters. The latter may be a smiling face, club, heart, diamond, space card symbol, or Greek character. PC*jr* has these built in. Graphics refers to control of the individual points on the screen. The graphics printer can also handle graphics. The Compact Printer is therefore an ideal choice as an inexpensive printer that is able to print anything that appears on the video screen.

The electronic interface that connects PC*jr* and the printer is serial. An optional cable connects the Compact Printer to the serial port on the back of PC*jr*. The baud rate for the printer is 1200 baud, or 120 characters per second. However, that is not the speed of the printer. The printer's top speed is 50 characters per second (CPS).

Unfortunately, the printer's average speed is less. The printhead, the mechanism that holds the heated pins, can print only when the head moves from left to right. To print the next line, the printhead moves back to the leftmost position and begins printing again. This is called *unidirectional* printing and is much slower than bidirectional printing (in either direction). The average speed for the Compact Printer is a slow 25 CPS. To print a standard letter takes almost two minutes. Although the printer is light and inexpensive, it is slow compared to the IBM Graphics Printer or other standard printers.

Other printers can be hooked up to PC*jr*. We'll run across printers later in this chapter when we discuss the Parallel Printer Attachment.

Joysticks

Unlike other IBM computers, PC*jr* comes with circuitry and connectors for two joysticks. Don't be deceived into thinking that a joystick is good only for playing games. HomeWord, one of the two word-processing programs for PC*jr*, can use a joystick. A joystick is a two-dimension (up-down/left-right) input device, commonly used in arcade games to move quickly and conveniently a cursor, plane, warship, or gun sight.

The IBM Joystick is more sophisticated than standard versions. Each joystick, which is purchased separately, has two normally open buttons (standard for most joysticks). One button is on the top, and the other is on the back. However, the stick itself has a "spring return" and a "free floating" mode. The former mode is like a deadman switch. Once released, it returns to the center position. In free-float mode, the stick stays in whatever position you put it when you release the stick. Generally, joysticks come in either mode, but seldom both. You can adjust the joystick to enter
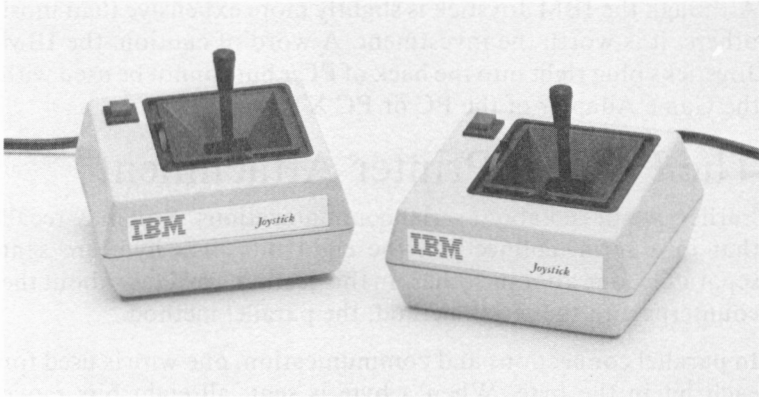
Pictured are the IBM Joysticks for the exclusive use of PCjr. One of the two buttons is shown; the other button is on the beveled back of the unit. The two controls (one left and one beneath the stick) control the electronic center of the joystick. Two controls on the bottom of the unit (not pictured) control the free-float and spring-return modes of the stick. (Photo courtesy of International Business Machines Corporation.)

either mode. Also, each axis can be independently set. This means that the horizontal axis can use the spring-return mode while the vertical axis uses the free-float mode, or vice versa. The switches for these settings are on the bottom of the unit.

The joystick is convenient for the various games and other programs that use it. Some programs assume that if you want to move the cursor, you move the joystick until the cursor is in the right position, then release the stick. The spring-return mode is used with many arcade games. When drawing pictures with graphics programs, the latter assume that the cursor should move whenever the stick does. These pictures are drawn more easily with a free-float joystick.

Each joystick also has separate controls next to the stick for electronically centering each axis. When the PCjr and its programs "read" the position of the joystick, PCjr's hardware returns a numeric value based on the position of the stick. As the joystick ages, the numeric value for a position can change. To counter this aging, the joysticks have controls to readjust the two axes. The same controls are used to adjust the numeric value for a joystick's position for various games.

Although the IBM Joystick is slightly more expensive than most others, it is worth the investment. A word of caution: the IBM Joysticks plug right into the back of PC*jr* but cannot be used with the Game Adapter of the PC or PC XT.

The Parallel Printer Attachment

Earlier, we talked about serial communications. You may recall that in a serial connection, the eight bits of a byte are sent separately, one after the other. In this section, we'll talk about the counterpart to the serial method: the parallel method.

In parallel connections and communication, one wire is used for each bit in the byte. When a byte is sent, all eight bits move simultaneously. Additional wires and signals help coordinate information movement between devices in a parallel connection. The advantage of a parallel connection is that information can be moved faster than in a serial connection. No additional overhead bits are sent. In fact, the computer's internal bus uses parallel lines to move information within the computer.

The most popular device that uses a parallel connection is a printer. To use a parallel printer, you need the Parallel Printer Attachment. The 3"-by-9.6" attachment connects to the right side of the PC*jr*. A plate is removed, and the attachment is plugged into the 60-pin I/O expansion bus. Four screws mount the attachment to PC*jr*.

The outside plate of the attachment uses a 25-pin female D connector, the same connector used on the PC and PC XT. An optional cable (many other companies as well as IBM offer it) connects the Parallel Printer Attachment to a Centronics-style connector. Centronics Data Products Corporation is a popular printer company whose style for parallel connections has become an industry standard. Most parallel printers use the Centronics-type connector and interface.

With the attachment and proper cable, PC*jr* can use almost any parallel printer, including the IBM Graphics Printer that is sold for use with the PC family. Additionally, many other printers that are capable of letter-quality print, graphics, or both, may be used with PC*jr*.

The Internal Modem

IBM offers the Internal Modem for PC*jr*. This serial device, a board that plugs into one of two dedicated 30-pin expansion slots, gives the PC*jr* the ability to communicate by telephone.

Computers do not use audio sound to transmit data. The computer's ones and zeros are expressed as levels of voltage. To talk on a telephone, the computer must transform the electrical signals into audio tones.

A *modem* is a *mo*dulator-*dem*odulator. The modulator turns the electric information into audio signals the telephone can hear and transmit. The demodulator turns the audio tones back into digital information the computer uses. A modem allows the computer to have a two-way conversation with another digital device.

The Internal Modem, so named because it is a modulator-demodulator and fits inside the PC*jr*, is a fully program-controllable 110- or 300-baud modem. Eleven or thirty characters per second are standard for most home computers. The modem is Bell 103 Series compatible, meaning that the modem will work with the popular AT&T 103 model. Most 110/300 baud modems are Bell 103 compatible.

The Internal Modem can handle communication with most types of microcomputer and time-sharing services, including Compu-Serve, The Source, Dow Jones, public computer bulletin boards, and many other information services.

The Internal Modem does not use the serial port of the PC*jr*. By plugging into the dedicated expansion slot, the modem leaves the serial port free for other uses. The modem also plugs directly into an RJ-11 modular telephone jack, the type of jack installed in most homes and many businesses. You don't need a telephone to use the modem, only the wall jack and normal telephone service. A provided cable connects the telephone wall jack and PC*jr*.

The modem has its own dialing unit and can dial a phone number under program control. Either pulse dialing (rotary-type phones) or dual-tone modulated dialing (Touch-Tone™) may be used. With the Internal Modem, PC*jr* can make a phone call to another computer or receive a phone call from one automatically, without
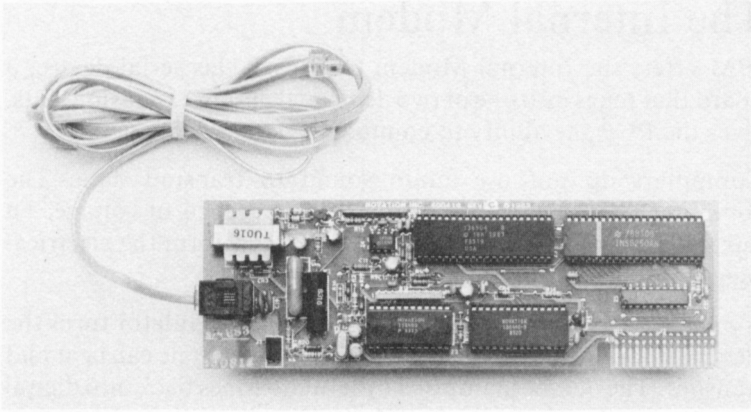
Pictured is the IBM Internal Modem manufactured by Novation, Inc. The modem has an identical INS8250 ACE that is used in PCjr for the serial port. The modular cable (upper left) that connects the board to a RJ-11 home telephone jack is also shown. (Photo courtesy of International Business Machines Corporation.)

your touching a phone. The modem can also tell the computer that a call is in progress or being received, or that the number being called is busy.

The Internal Modem, made by Novation, uses another INS8250, the chip that drives the PC*jr*'s serial port. The modem is programmed by printing characters to the modem. The characters you print to the modem are identical to those used by other Novation models. Its own diagnostics can determine whether the modem is acting properly or whether a hardware problem exists.

For those who wish to telecommunicate with other computers, the Internal Modem is an attractive addition to PC*jr*. Since the modem is internal, the serial port remains free. This is important to those who have the IBM Compact Printer, which uses the serial port. The auto-dial and auto-answer features are convenient. All of the modem's features are controllable through software. Once the modem is installed, no switches are set; all features are controlled by you and your programs. The on-board diagnostics and error detection make the unit easy to use.

Odds and Ends

This section covers various parts of the PC*jr* System Unit not discussed elsewhere, including the audio alarm, the light pen jack, the sound subsystem, the transformer, and the I/O expansion bus.

Inside PC*jr* is a little Sonalert™ speaker. It is not the same as the 8-ohm audio speakers in other PC machines; all it can do is beep. If you want something besides a beep, you'll need to use an amplifier and speaker, a television set, or a monitor with a speaker.

The sound subsystem is a significant advance for the PC family. The sound chips inside the PC*jr* make it possible to play three different notes or "voices" simultaneously. This polyphonic (multiple note) sound is fully supported by Cartridge BASIC.

The sound produced by the subsystem is carried on a composite signal to an attached television or monitor with a speaker. There is also a jack on the back of PC*jr* that can be hooked to an audio amplifier, which can be part of a normal stereo system. PC*jr* plays its sound through the speakers connected to the amplifier. However, PC*jr*'s sound is not stereo, but just polyphonic.

On the back of PC*jr* is a jack for a light pen, another input device. Like the joystick, the light pen can "point" and move the position of the cursor. The most common use of the pen is to make selections from a menu presented on the video screen.

Instead of typing the choice, you point the light pen to the appropriate spot on the screen and press the pen's trigger. The trigger can be a small push switch or a capacitance switch that is sensitive to the touch of a finger. This switch triggers a small block that flashes across the video screen. In the tip of the pen is a directional, light-sensitive element. When the light pen's tip feels the box on the screen, the light pen software returns the horizontal and vertical coordinates of the box. In turn, the program using the light pen knows what spot you have selected and "enters" your choice.

Cartridge BASIC supports several commands for light pen use. IBM does not sell light pens, but several outside manufacturers

do, and some even supply sophisticated software you can use in your own program for a light pen. The connector for the light pen is on the back of PC*jr*.

The power transformer comes with PC*jr*. As with most video games, the power transformer plugs into a 110-volt a.c. wall outlet and provides power to PC*jr*'s System Unit. The transformer weighs 2 pounds, 13 ounces, and supplies up to 33 watts of power. The cord for the transformer is 10.16 feet, long enough to reach most a.c. home or office wall receptacles. The transformer breaks the a.c. wall power into the three necessary d.c. voltages for PC*jr*'s internal components, including the disk drive. The transformer uses a step-down technology that is popular with most video games and similar home computers.

There were two reasons for using an external transformer in PC*jr* rather than the internal power supply used in the rest of the PC family. By using an external transformer, IBM could keep the size and weight of the System Unit down. Also, there is no cooling fan inside PC*jr*. The PC*jr*'s System Unit is air (convection) cooled. The heat generated by an internal power supply would have forced the use of a fan in PC*jr*. This would have added weight and bulk to PC*jr* and increased its price.

The I/O expansion bus is located on the right side of PC*jr* used by the Parallel Printer Attachment. The 60-pin connector could be attached instead to devices like an expansion chassis. It is interesting to note that the I/O expansion bus of the PC family uses 62 lines, two of which are used for the +5 volts d.c. These lines can be eliminated, together with one that provides a signal from the 14.1818 MHz oscillator crystal (the basis of PC*jr*'s system clock signal), and the I/O expansion bus of PC*jr* would remain completely functional.

Looking back

In this chapter we have taken a look at the heart of PC*jr*—the System and Keyboard Units. We saw that the use of the 8088 CPU provides for the basic capabilities of PC*jr* and signals that IBM deliberately intends to maintain compatibility between PC*jr* and the rest of the PC family. PC*jr*'s 64K ROM contains

extensive software that makes the computer functional when you turn it on. 64K RAM is enough for minor uses of PC*jr*, but most people will want the larger 128K. The built-in connectors for the video display, amplifier, light pen, serial port, joystick, and others give PC*jr* a capability level higher than that of most other home/personal computers. The optional equipment, such as the printer attachment, Internal Modem, and other equipment demonstrate PC*jr*'s versatility.

This chapter focused on the hardware of PC*jr*. Hardware is half of the computer. The other half is the software that makes the hardware work. In the following chapter, we review PC*jr*'s software, and PC DOS, the disk operating system for the entire PC family.

4

DOS

In the last chapter, we discussed the PC*jr*'s hardware. This chapter begins the discussion of software, the instructions that tell the computer what to do. Recall that there are several layers of software in a computer. The bottom layer in PC*jr* is the I/O system in the ROM. The next layer is DOS, the disk operating system.

An *operating system* is the set of programs and subprograms that directs the fundamental operations of a computer. The I/O system in the ROM is an operating system. If you use a disk drive, you need a *disk operating system,* the group of programs that controls the computer and its disk storage.

The IBM Personal Computer's Disk Operating System, which the computer industry quickly abbreviated to PC DOS, is the collection of programs that helps you manage PC*jr*'s resources (the RAM, disk storage, printers, keyboard, display, etc.).

Some Facts about PC DOS

DOS is important because it gives you control of the the computer; DOS affects PC*jr*'s "personality."

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PC DOS is a friendly operating system. If you make a mistake, the error message that PC DOS displays is understandable. The prompts and messages that direct the use of the programs are easy to follow.

You can learn PC DOS simply "by doing." Most of PC DOS's on-screen directions are easy to comprehend and follow. You can experiment with the commands and learn how to use the operating system.

PC DOS is the software that loads your programs and data from the disks. The system's file work is fast; a 16K program typically loads in less than two seconds.

PC DOS can handle files as large as 16 gigabytes (16 billion bytes), but the floppy diskette drive of PC*jr* holds only 360K. Although this multigigabyte capacity is not fully used now (an understatement!), the capability is there for future use with such items as video disks.

PC DOS is flexible. One concept you'll read about later is device drivers. Device driver software lets your PC*jr* use a non-IBM device as easily as the computer uses most IBM equipment.

Overall, PC DOS operates efficiently, has great flexibility, is difficult to "crash" (lock up into an endless loop of instructions), and is friendly to operate. PC DOS is an excellent foundation for the software of PC*jr* and the entire Personal Computer family.

The History of PC DOS

PC DOS has evolved through several generations. Tim Paterson, of Seattle Computer Products, is the original author of the operating system, which was first marketed as SCP 86-DOS™ (the 86 referring to the 8086 microprocessor). Microsoft®, the producer of the BASIC language used with PC*jr*, later bought the exclusive rights to market 86-DOS and renamed the operating system MS-DOS®. The first version of MS-DOS was 1.00. Then Paterson joined Microsoft, where he helped complete the revisions of MS-DOS, up to Version 2.0, before he returned to Seattle Computer. During this time, many computer manu-facturers licensed MS-DOS from Microsoft for use on their systems. One of these companies was IBM.

Since IBM acquired MS-DOS, it has released four versions of PC DOS. The first PC DOS version, V1.00, was released with the first Personal Computers; the second IBM version, V1.10, when IBM introduced double-sided disk drives for the IBM PC. PC DOS V2.0 was presented with the IBM XT in March, 1983. The most current version, V2.1, was announced with PC*jr*.

A full discussion of DOS can occupy an entire book. In fact, Que has a book devoted to the PC DOS operating system, the *PC DOS User's Guide*. Because DOS is a broad subject, it cannot be completely covered here in this book. We'll discuss PC DOS V2.1, currently the only disk operating system for PC*jr*, and briefly mention the differences between V1.0, V1.1, V2.0, and V2.1. We'll also explain why PC DOS V2.1 is the only version you can use on PC*jr*.

The Different DOS Versions

Like most software, DOS has continually evolved with the changing hardware of the PC family. The first major change was DOS V1.1, which appeared because of the introduction of double-sided disk drives. The next version, DOS V2.0, handled the hard disk of the PC XT. DOS V2.1 was released to handle the half-height disk drive of PC*jr*.

Changing hardware is not the only reason why IBM releases a new version of DOS. Each new release usually has additional features that make using the computer easier. To see how PC DOS has evolved, let's look at the changes that have occurred with each release of DOS.

PC DOS V1.1 added routines to handle double-sided disk drives and commands to handle printers attached to the serial port. The commands that set the date and time were put into COM-MAND.COM so that you no longer need to load separate programs to set or display the date or time. A couple of small bugs in DOS V1.0 were also fixed.

Although only a few changes have been made between V1.0 and V1.1, the following major changes have occurred between Versions 1.1 and 2.0:

- More support for serial devices, graphics printers, and systems that use two displays (one monochrome and one color)
- 360K disk drives (instead of 320K)
- Support for hard disk drives
- More batch-processing commands
- Background printing
- More control over the disk, display, and keyboard
- Installable device drivers and extended control for PC DOS operations
- Hierarchical (tree) disk directories and support programs
- Redirection of input/output and piping
- New utility programs (filters)

These modifications, along with any unfamiliar terms, will be explained later in this chapter. The following changes between PC DOS V2.0 and V2.1 have also been made:

- Correction of some problems (bugs) with V2.0
- Support of the half-height JC*jr* disk drive

The most significant change in V2.1 is the provision of software to handle the delay needed by PC*jr*'s half-height disk drive.

What You Need to Run PC DOS

To run PC DOS, you need the following equipment:

- A PC*jr*, PC, or PC XT
- At least one disk drive with cable and adapter

If you are using the PC*jr*, the following additional pieces of equipment are strongly recommended:

- 64K Memory and Display Option
- Cartridge BASIC

You can run PC DOS on PC*jr* without the 64K board, but you won't be able to do much, since PC DOS uses about 24K of RAM. PC DOS can take up even more room, depending on which optional functions you use. Because the video screen uses 16K, only 24K will be left. Cartridge BASIC takes another 6K, leaving only 18K. You can run only very small programs in 18K of RAM.

If you plan to use BASIC with DOS, you must purchase Cartridge BASIC. The PC*jr*'s built-in Cassette BASIC does not work with DOS.

If you purchase the entry PC*jr*, you'll need to add the disk drive and memory/display board; if you bought the enhanced version, you already have these items. However, PC DOS V2.1, at $65, and Cartridge BASIC, at $75, are "optional" items you must purchase.

Now that you have seen the differences among the four versions of DOS and what you need to run it, let's examine each major part to see how it works and how you use it.

Inside PC DOS

You can divide PC DOS into three functional areas: the I/O system, the command interpreter, and the utility programs.

I/O System

The *I/O system* of PC DOS, similar to the I/O system in PC*jr*'s ROM, is divided into two areas: the nondisk handlers and the disk handlers. The nondisk handlers extend the capabilities of PC*jr*'s ROMs and such control devices as the keyboard, video display, and serial port. Nondisk handlers are in a disk file called IBMBIO.COM.

The disk handlers, found in a disk file called IBMDOS.COM, manage the disk drives. These disk handlers maintain the directory (a list of files on the disk); locate, place, or retrieve information on the disk; and perform several other built-in functions. However, it is not really important to know much about the disk and nondisk handlers of DOS. You need only to know that they do the necessary work to control and handle the various hardware devices of the computer.

The *command interpreter* is in a disk file called COM-MAND.COM. Of the three files discussed earlier, COM-MAND.COM is the only one you can examine and modify. The other two files are *system files,* which require special instructions to reach.

The last functional area of PC DOS is the set of *utility programs* you use for housekeeping tasks. These programs format diskettes, give the statistics on the disk and memory use, and compare diskettes and files. The utility programs reside on the disk and must be loaded into RAM memory to be used.

You should know more about COMMAND.COM and the utilities that come with DOS V2.1 because you actually interact with these parts of DOS.

COMMAND.COM

COMMAND.COM performs four different functions for you, PC DOS, and PC*jr*.

First, COMMAND (what we'll call COMMAND.COM) handles device interrupts (devices "demanding" attention), the Ctrl-Break (stop processing) function, critical errors (disk-error or divide-by-zero problems, for example), and end-of-program housekeeping. With end-of-program housekeeping, if the copy of COMMAND in memory is destroyed by the preceding program, COMMAND will reload itself from the disk.

The second function that COMMAND performs is to process *batch files,* which are text files that contain commands for the operating system. When DOS executes the commands in a batch file, DOS "believes" you are typing each command on the keyboard. By building up and using batch files, you can make DOS execute one command, or hundreds, simply by typing the batch file's name.

An example of a batch file is AUTOEXEC.BAT, which runs specified commands automatically. When PC DOS is loaded (booted) initially, COMMAND searches for a file on the disk with the name AUTOEXEC.BAT. If the computer does not find the file, PC DOS asks you for the date and time. If DOS finds the file, PC*jr* executes the commands in the file. Computerists use the term *turnkey* to describe the computer's ability to run a program automatically when the computer is turned on.

Most of the IBM-marketed software products use the AUTO-EXEC.BAT feature. For example, VisiCalc uses this file to run a

single command, VC80. The command executes the 80-column display version of VisiCalc. When the VisiCalc diskette is booted, PC DOS automatically loads and executes the VisiCalc program. You don't need to type anything to start the VisiCalc program; you simply turn on the computer with the VisiCalc diskette in the disk drive.

A third major function of COMMAND is to run built-in housekeeping commands. *Housekeeping* includes the tasks that run the computer but do not actually contribute to productive work. Formatting diskettes, checking directories to see what files are on the disk, and copying or erasing files are examples of housekeeping. You don't get productive results, as you do when you run your applications programs, but you must perform these tasks in order to make the computer easy to use.

Utility Programs

Housekeeping programs are stored both in the COMMAND file and on the disk. Those stored in the COMMAND file are built-in programs called *internal commands*. But whether you call them commands or programs does not matter because a command *is* a program. What is important is that these commands are built-in. This means that whenever you work with COMMAND, you can use any of these programs. The internal commands of COMMAND are listed in table 4.1.

Table 4.1
List of PC DOS V2 Internal (Built-in) Commands

File/disk commands:

COPY	Copies files or information between the disk drive(s) or other devices (keyboard, video screen, printer, etc.)
DEL or ERASE	Deletes a file from the disk
DIR	Gives a list of the files on a disk
REN or RENAME	Changes the name of a disk file

Table 4.1 *(continued)*

TYPE   Shows the contents of a file on the video
            screen

VERIFY   Sets whether information should be
            checked after it is written on the diskette,
            to ensure that it was recorded correctly

VOL   Shows the name of the diskette (volume
            label)

Hierarchical directory commands:
  CD or
  CHDIR   Changes the current directory

  MD or
  MKDIR   Makes a new subdirectory

  PATH   Tells DOS where to find programs or
            batch files that are not in the current
            directory

  RD or
  RMDIR   Removes a subdirectory

Date/time commands:
  DATE   Displays or sets the date of PC*jr*'s
            internal calendar

  TIME   Displays or sets the time of PC*jr*'s
            internal real-time clock

Miscellaneous commands:
  BREAK   Controls when PC DOS is to check for
            the Ctrl-Break (abort program)
            keystrokes

  CLS   Clears the video display

  PROMPT   Sets the system prompt (normally *A*>) to
            anything you specify

  SET   Displays or allows you to set additional
            information into PC DOS that can later
            be used by programs

Table 4.1 *(continued)*

VER	Displays the version of PC DOS you are using

Batch file subcommands:

ECHO	Controls whether messages will be displayed from the batch file, or will display a message unconditionally
FOR..IN.. DO	Allows repeated use of a command for a set of files
GOTO	Lets PC DOS jump to another part of the batch file; works like BASIC's GOTO command
IF/ IF NOT	Allows PC DOS to execute commands based on a condition
SHIFT	Moves the batch file parameters one position to the left
PAUSE	Pauses the execution of the batch file until a key is struck
REM	Displays a remark from the batch file on the video screen unless ECHO is off

Housekeeping programs stored on the disk are called *external commands,* which are located on the PC DOS system diskette. The difference between an internal and external command is that the latter is disk based. To run these housekeeping programs, you must have in the disk drive the floppy diskette that holds the program. Table 4.2 lists the external commands of PC DOS.

The final function of COMMAND is to load and execute programs from the disk. When you type the name of a program that is on the diskette (a file that has the suffix of .COM or .EXE.), COMMAND loads the program into RAM memory and starts the program running. External commands are programs that are loaded into memory and executed by COMMAND.

Table 4.2
List of PC DOS V2 External (Disk-based) Commands

File/Disk Commands

CHKDSK	Reports statistics about used and free space on the disk and RAM memory; also checks and repairs certain aspects of a diskette/disk
COMP	Compares disk files
DISKCOMP	Compares entire diskettes
DISCOPY	Duplicates diskette
FORMAT	Initializes diskettes/disk so that they can be used and optionally places PC DOS on the diskette/disk
RECOVER	Recovers a file or entire diskette with bad sectors
SYS	Places DOS on a properly formatted diskette/disk

Hard disk commands:

ASSIGN	Tricks programs into using a disk drive that is physically different from what the program requests
BACKUP	Backs up the hard disk
RESTORE	Restores backed-up hard disk files
TREE	Displays a list of the directories on a diskette/disk and the files in the directories

Programming tools:

DEBUG	Assembly language debugging program
EDLIN	Line editor for PC DOS
EXE2BIN	Changes correctly formatted .EXE program files in .COM or .BIN files
LINK	Program linker

Table 4.2 *(continued)*

Filters:

FIND	Displays lines from a file that contain or do not contain a specified series of characters
MORE	Displays a screenful of information, then pauses until a key is depressed
SORT	Sorts the lines in a file

Miscellaneous commands:

GRAPHICS	Lets the computer dump the display on the graphics screen to the printer
MODE	Allows you to set the printer, video display, serial port, and system printer characteristics
PRINT	Allows the printing of a file while the computer is working with another program (background printing)

A Look at the Commands

The major PC DOS commands, grouped by function in the two tables, are briefly explained in the following sections. Each command is followed by (*I*) or (*E*), designating an internal or external command, respectively.

The File/Disk Commands

The PC DOS commands that are used most often are those that affect files, disks, and diskettes. The term *disk* refers to either a floppy diskette or a hard disk. PC*jr* does not have a hard disk. However, PC DOS V2.1 can be used on PC*jr*, the PC, or PC XT. Because the operating system can work on any of these three machines, all commands work on floppy disks or hard disks. This versatility means that PC*jr* owners get with PC DOS V2.1 a few extra programs they won't use. However, the term is used here to show that the command works on both types of disk drives.

The most frequently used PC DOS command is DIR (*I*), the command that displays the list of files on the disk. DIR also shows the size of the files and the date and time that the file was created or last changed. The date and time in the directory are based on the real-time software clock inside PC*jr*.

COPY (*I*), another frequently used command, makes a copy of information. You use COPY frequently to copy files between disks or diskettes. You can also copy information between the disk drive, keyboard, video screen, printer, serial port, or any other device.

ERASE (*I*), or its shorthand form DEL (*I*), removes a file from the disk. When you delete the file, the space it occupied is then freed for use by another program or data file.

RENAME (*I*), or REN (*I*), changes the name of a file. Every file in a directory must have a name. The name starts with a root name that is one to eight characters long; an optional suffix, called an *extension,* contains one to three characters. If you use an extension with a file name, separate the root name from the extension with a period (.). Renaming a file does not change any information inside the file.

CHKDSK (*E*) tells you how much free space is on the disk, how many files are on the disk, how much disk space the files use, how much RAM memory is in the system, and how much RAM memory is free for use by your programs and data. CHKDSK also can analyze and repair some faults with a disk.

FORMAT (*E*) is the program you must run before you can use a new diskette. After the diskette is formatted, you can use it for storing programs and data. Because FORMAT erases any information that was on the diskette, don't FORMAT a diskette that holds information you want to keep.

FORMAT can also put a copy of DOS on a diskette. You don't need to put DOS on all diskettes, only those that will be used to start (boot) PC*jr* and DOS. Once DOS has started, you don't need a diskette with DOS on it until you restart the computer system.

DISKCOPY (*E*) is the program that makes exact copies of your diskettes. It makes a track-by-track copy of one diskette onto another. You can make this duplicate diskette even though you have only one disk drive. DOS will prompt you to change diskettes at the appropriate time.

SYS (*E*) is the program you use to put DOS on preformatted diskettes, like those you get when you buy a software package or diskettes with previous versions of DOS. SYS will work only on diskettes that have been formatted in a certain way. Check your DOS manual to see which diskettes can be SYSed.

The PC*jr* has a built-in real-time clock that keeps both the time of day and the day of the year. Because this clock exists in software, it is not as accurate as a good wristwatch, but it is used to time-stamp disk files. As mentioned earlier, DOS records the date and time when you create or change a disk file. You can use this information to find the most recent version of a letter, document, program, or data file.

To set the date or time, you use the DATE (*I*) and TIME (*I*) commands. When DOS starts up, it automatically executes these two commands. You must enter the date and time so DOS can record the correct date and time with your files.

The real-time clock, which may also be used by BASIC programs, will be mentioned again in the next chapter.

Programming Tools

You may have noticed that when you buy PC DOS, you also get an editor, a linker, and a debugger. These software programs are programming tools that help programmers.

EDLIN (*E*) is a line editor for creating and editing text files. You can insert, delete, change, and display lines of text. You can also search for text in the file and automatically delete or replace text as you wish. You can use EDLIN to create and edit batch files, program text (the humanly readable source code), data files, and any other file that involves text characters rather than commands (object code).

EDLIN is not a powerful text editor or word processor, but merely a line-oriented editor. With EDLIN, you can edit only one line of text at a time. However, EDLIN is a useful line editor that is included with PC DOS at no additional charge. Also available, at no extra charge, are several screen-oriented editing programs that allow you to edit any text on the video screen.

LINK.EXE and DEBUG.COM are programming tools that most PC*jr* owners may never use. The LINK.EXE (*E*) program converts specially formatted program portions and/or joins them together. After this linking, the new program may be altered to execute from a specific starting point in memory (a .COM file, for example). Several useful options are available for the linking process and produced output files. LINK can be used with the IBM programming languages, the BASIC Compiler, FOR-TRAN, Pascal, Macro Assembler, and other programming languages and assemblers.

The only two PC*jr*-compatible languages that use LINK are the Macro Assembler and the BASIC Compiler. For PC*jr* owners who use only "canned" software programs or IBM BASIC, LINK is not important.

DEBUG.COM (*E*) is an interactive machine-language program debugger. It allows you to load a program and examine, alter, and re-examine the instructions. Any disk file or memory location may be examined or altered, with the exception of ROM memory, which cannot be changed. DEBUG is an extensive programming tool, but most PC*jr* owners will use DEBUG rarely, if at all.

Miscellaneous Commands

CLS (*I*) is a built-in command that erases the video screen and puts the cursor at the upper-left corner of the screen. CLS is a quick, easy-to-use command for clearing the video screen.

MODE (*E*) is several commands in one, which performs the following tasks:
- Sets the baud rate, parity, and retries for the serial port
- Sets the video screen for the Monochrome Display or color displays and 40- or 80-character-per-line display

- Tells DOS which connector has the "system" (usually used) printer
- Switches between the Monochrome Display and color displays on a PC or PC XT

The first three functions of MODE will be used by many PC*jr* owners. Setting up the serial port, changing the width of the video display, and establishing which port (serial or parallel) has the printer to use can be done with the MODE command. When setting up the video display, MODE can also print a test-pattern line of characters and shift the line left or right. Some TVs and monitors need this shifting of the display by the computer. The last part of MODE, switching between different displays, affects only PCs and PC XTs.

GRAPHICS (*E*) is loaded into memory to let you screen-print the graphics screen. When you screen-print, the printer prints a copy of what is on the video display. The GRAPHICS command lets you print what is on the medium- or high-resolution graphics screen if your printer is the IBM Graphics or Compact Printer or you have a printer that acts like either of these two.

GRAPHICS takes about 680 bytes from your remaining RAM memory. To free the memory used by GRAPHICS, reboot PC DOS.

PRINT (*E*) controls the background printing for PC DOS. The PRINT command can print what is in a disk file while the CPU is waiting for something to do. Background printing lets you print a disk file while another program is running.

Unfortunately, not all programs produce files that can be PRINTed. PRINT does not handle boldface, underscoring, or many other features of word-processing programs. PRINT is not as versatile as a print spooler, which intercepts characters for the printer and buffers them in RAM memory. Almost any program can use a RAM printer spooler (really a printer buffer). But a printer spooler does not have much memory to work with on PC*jr*. BASIC and DOS leave only 88K of RAM on a 128K PC*jr*, so RAM print spoolers will be used less frequently on PC*jr* than on its bigger brothers.

PRINT, like GRAPHICS, loads into memory and steals about 3200 bytes. To free this space up for your programs and data, you must reset the computer.

Hard Disk Commands

Although most of the commands for the hard disk won't be usable by PC*jr,* four are briefly noted here.

BACKUP (*E*) makes a copy of the files on the hard disk onto floppy diskettes. RESTORE (*E*) reverses this process. Backing up a disk or diskette is important. If the diskette or hard disk is damaged, you will lose information. The BACKUP and RE-STORE programs provide a way to protect the information on the hard disk.

TREE (*E*) lists all the directories on a disk and all the files in the directories. A hierarchical directory command, TREE is mainly for hard disk users.

ASSIGN (*E*) is a program that you might use with PC*jr.* ASSIGN tricks a program into using a disk drive different from the one the program specifies. When the PC XT appeared, most of the programs used the minifloppy disk drives. To use some of these programs on the hard disk, the ASSIGN command was used to fool the programs into using the hard disk instead of the floppy disk.

Since PC*jr* has only one disk drive, you might use this command to fool programs that try to use two disk drives but could be used on only one disk drive.

Hierarchical Directory Commands

Most PC*jr* owners will never need to know the hard disk or hierarchical directory commands. These are important to those people who use the PC XT or PC with a hard disk. However, we'll examine the concept of hierarchical directories because you can use this feature with the floppy disk.

Most operating systems, including PC DOS V1, have only one place on a disk where the names of the files are stored: the directory. A single directory works well if fewer than a hundred

files are stored on the disk. When you use a file, DOS searches the directory to find where the file is stored. When more than 100 files are stored on a disk (a hard disk can store thousands of files), the search slows the computer down. The solution for this directory problem is to have more than one directory on a disk. This is how the UNIX/XENIX operating system solves the problem. UNIX/XENIX uses a tree-like or hierarchical approach to directories.

A disk starts with a main, or *root,* directory. Like a normal directory, this directory can hold program and data files. The root directory can also hold subdirectories that, in turn, can hold program and data files and other subdirectories. The system looks like a family tree. The root directory is the parent to one or more child subdirectories, which can own other child sub-directories, and so on. You can keep adding subdirectories as long as the disk has free space.

To use a file in a different directory, you step through the various subdirectories until you get to the directory you want. Each directory has a name. When you move through or use a directory, you use its name. The series, or chain, of directories that you travel is called a *path.*

Most PC*jr* owners will never use the hierarchical directories. It is easy to forget where you have put a disk file when a disk has many subdirectories. Each subdirectory takes up some disk space that you might want your programs or data files to use instead. Hierarchical directories are excellent for hard disks, but not so useful for floppy diskettes.

The commands used for the hierarchical directories are CHDIR, MKDIR, and RMDIR, also called CD, MD, and RD. You use MKDIR (*l*) to make a subdirectory, RMDIR (*l*) to remove a subdirectory, and CHDIR (*l*) to move into another (change the current) directory. You may want to experiment with these commands just to see how hierarchical directories work with PC*jr.*

Filters

To understand filters, first you need to know about I/O redirection. Like hierarchical directories, I/O redirection is borrowed from UNIX/XENIX. However, many PC*jr* owners will find a good use for I/O redirection.

When a program asks for input, you type on the keyboard. When the program displays information, it is sent to the video display. The keyboard (for input) and the video display (for output) are the standard I/O devices.

The only way a program can use a disk file is to have specific instructions to open, read and/or write, then close the disk file. If information is to be printed, the program must issue specific instructions for the computer to send the information to the printer.

The redirection of I/O allows exceptions to these conditions. Two new characters, the less-than sign (<) and the greater-than sign (>), are used. The < tells the operating system to get information from a file or device rather than from the keyboard. The > tells the system to put information into a particular file or send it to a device other than the video display. When the program is run, its name and < and/or > (either, both, or neither) are typed with a file or device name. For example, the command

    DIR > MYFILES

prints the disk's directory to a disk file called MYFILES. The line

    DIR > PRN

prints the directory on the printer.

Piping is an extension of the I/O redirection. The output of the first program becomes the input to a second program. These programs may be chained together to form useful combinations. The vertical bar (|) designates a pipe. Information generated between programs is placed into a temporary disk file for use by the next invoked program.

PC DOS provides several utility programs that can be used with I/O redirection and piping. FIND (*E*) locates a *string* (series of alphanumeric characters), optionally displays lines with or

without the string, and prints the specified lines with line numbers. SORT (*E*) sorts lines in either ascending or descending order. MORE (*E*) displays 23 lines of input and the message "MORE," then waits for a keystroke.

These programs are called *filters,* or *black boxes*. Each filter accepts information from the standard input (keyboard), works on that information, then sends the information to the standard output (the video display). The term *black box* is used because you don't need to know how the filters work. You need to know only what the filters do to the information you give them.

When you combine filters with pipes and redirection, you can do some very useful work without even writing a program. For example, to get a sorted directory of a disk, type

        DIR | SORT

A sorted directory will then appear on the video display. The command

        DIR | SORT | MORE

displays one screenful of the sorted directory, then waits until a key is pressed, and displays another screenful. The command

        DIR | SORT > PRN

sends the sorted list to the printer.

The redirection of I/O and piping are important tools. By using combinations of filters and these functions, you can avoid writing many short, one-shot programs.

Filters and redirection don't take the place of all applications programs. Most regular applications programs, such as those for accounting, spreadsheets, and data management, cannot be replaced by redirection of I/O and piping.

Batch commands

PC DOS has several powerful commands for handling batch files. All of these internal commands are built into COMMAND. Remember that these commands can be used only in a batch file; you cannot use them at any other time.

ECHO turns on or off the display of the commands as they are executed, including comments that use the REM (remark) batch command. All versions of PC DOS start with ECHO turned on. ECHO can also unconditionally display a message, even if the display of commands is turned off (ECHO OFF).

The FOR..IN..DO command allows you to repeat one command for several different files. This procedure is called *iterative* (over and over again) processing.

GOTO lets DOS "jump" to another part of the batch file and execute the commands there. A label consisting of eight characters without spaces and preceded by a colon (:) is typed on a line in the file. When DOS encounters the line *GOTO labelname,* DOS jumps to the batch file line following the label. By itself, the GOTO command is not very useful. When combined with other commands, however, GOTO is a powerful batch command.

The IF command is simple. If the condition tested is true, DOS executes the statement on the line. If the condition is false, DOS ignores the statement. IF NOT works in the opposite way. IF and IF NOT may test whether two strings (sets of alphanumeric characters) are identical, whether a file exists, or whether a special flag has been set by a program called ERRORLEVEL. In DOS V2.0, only the BACKUP and RESTORE commands use this flag.

When a batch file name is typed, a set of strings, separated by spaces, may also be typed. These strings can be used by the batch command. The strings are called *command line arguments* or *command line parameters.* Typically, the arguments are names of files to be handled by the batch file. PC DOS recognizes a maximum of ten command line arguments. The SHIFT command is used to trick PC DOS into using more than ten. When given in the batch file, SHIFT moves the arguments left, making the second argument the first, the third argument the second, and so on. When SHIFT is used, the original first argument is discarded.

PAUSE causes DOS to halt the batch file processing, displays a message for the person to strike a key when ready, and waits for a keystroke. These actions let the user change diskettes or be sure that the right diskette is in the disk drive.

REM and PAUSE can display optional comments. Both batch commands are affected by ECHO. IF ECHO is on, the comments are displayed. If ECHO is off, no comments are displayed on the screen. However, the PAUSE message to strike a key is always shown on the screen.

Other Features of DOS V2.1

Additional features of DOS V2.1 include installable device drivers, disk buffers, and the "phantom" disk drive. These features are described in the following sections.

Installable Device Drivers

PC DOS V2.1 has provisions for installable device drivers. A *device driver* is the software that allows the operating system to use a device. It may be a printer, a plotter, a disk drive, a voice input/output board, a terminal, or any other peripheral.

When you load (boot) PC DOS, it checks for a file named CONFIG.SYS. To use a device driver, you enter a line such as

    DEVICE = ANSI.SYS

ANSI.SYS is the name of one device driver that comes with PC DOS. If PC DOS finds the CONFIG.SYS file and if the line above is in the file, DOS will load the device driver into memory and link the device driver to DOS.

Device drivers let PC*jr* use devices, like serial printers, that use software protocols for handshaking. A device driver is written by the hardware manufacturer and distributed with the product. You simply copy this driver software to your boot disk, add the name of the file as in the previous example, and reboot PC*jr*. When PC DOS is booted, it will load and use the new driving software.

Writing a device driver is a complex task that should be performed by a person who is not only skilled in assembly language programming, but also familiar with PC DOS and the physical aspects of the device. Once the driver is written and functioning correctly, it is easy to install and use. Unfortunately,

many hardware manufacturers aren't taking advantage of this feature yet.

The ANSI.SYS device driver that comes with PC DOS holds the software that uses the ANSI terminal codes with the keyboard and video display. The American National Standard Institute (ANSI) has published a standardized set of special characters that can be printed to control the video screen and keyboard. If you use BASIC or Logo on PC*jr*, the ANSI.SYS device driver won't be of much use. It is helpful only for those using programming languages other than BASIC.

Disk Buffers

A feature usable through CONFIG.SYS DOS is the disk buffer, which enables you to control some factors that affect PC DOS's performance.

A *disk buffer* is an area set up in RAM that holds information going to or coming from the disk. If many files are used in a program, you can set up 10 to 20 disk buffers to increase the performance of PC DOS. If your programs do a lot of skipping around in a data file, more disk buffers will speed up DOS.

If your program reads only a portion of a disk sector (a disk sector is 512 bytes), PC DOS puts the disk sector into a disk buffer. The next time your program reads a little more information for the same sector, DOS does a high-speed memory-to-memory transfer instead of rereading the disk. That's how disk buffers improve performance. DOS keeps some information from the disk sector in RAM memory instead of constantly rereading the information from the disk drive.

Accounting and data management programs usually benefit most from disk buffers. If the program reads or records a complete file (or complete disk sectors) at one time, the disk buffers will not improve the disk performance.

Each additional buffer (PC DOS starts with two) increases the size of PC DOS by 528 bytes. You'll need to balance the amount of RAM memory given to disk buffers against the amount of RAM memory your programs and data will need.

Disk Drives and Names

Disk drives have names, as do files and directories. The scheme for disk drive names is simple: a single character followed by a colon (:). The first disk drive in a computer system is called A:, the second B:, the third C:, and so on.

The colon in the disk drive name is important; without a colon after the letter, PC DOS will think you have entered a file name, not a disk drive name.

Since PC*jr* has only one disk drive, its name is A:.

The Phantom Disk Drive

PC*jr* actually has two disk drives, but the second one is located within the first. We call drive B the phantom disk drive.

When you copy programs between diskettes, you need two disk drives. If your computer system has only one floppy disk drive, PC DOS turns this single drive into two apparent (logical) disk drives.

When you use drive B, PC DOS will prompt you to put the diskette into the disk drive you wish to use and hit a key to continue. When you switch back to A:, PC DOS repeats these steps. This is how one physical floppy disk drive can be two disk drives.

With this two-drives-in-one feature, you can do almost anything with the one disk drive that you can do with two. This feature is helpful for PC*jr* owners.

Booting DOS

PC DOS can be started in two ways. You can turn PC*jr* on (power up), or you can perform a system reset. You do a *system reset* by holding the Ctrl (supershift key), the Alt (another supershift key), and DEL (delete) key. This sequence restarts the computer from scratch. When you reset the system, anything that was in the RAM memory is lost.

Turning the computer on is different from doing the system reset while the computer is on. The *power-up self-test* is performed

only when you turn PC*jr* on. The self-test takes a few seconds to complete. By doing a system reset, you bypass the self-test and save those few seconds.

After resetting the system or powering up PC*jr,* the ROM in PC*jr* searches for the floppy disk adapter card. If the card is found, the disk drive is turned on and the recording head is positioned to the front of the disk. The ROM reads in a small piece of software from the disk.

After this software is read into the memory of the computer, the computer attempts to read a file called IBMBIO.COM. If this is the first file on the disk, it is loaded, and the ROM turns control over to IBMBIO.COM, which adjusts itself for the hardware of the computer. IBMBIO.COM then loads IBMDOS.COM. Before IBMBIO.COM runs IBMDOS.COM, however, IBM-BIO.COM looks for a file called CONFIG.SYS, the configuration file. If this file is on the diskette, IBMBIO.COM follows the directions in the configuration file.

After relocating itself in RAM memory, IBMDOS.COM loads the COMMAND.COM file and gives control of the computer system to the file. COMMAND now looks for the AUTO-EXEC.BAT file. If AUTOEXEC.BAT is in the root directory of the disk, COMMAND executes the directions in this batch file. If AUTOEXEC.BAT is not in the root dirctory, COMMAND runs the DATE and TIME commands, prints a sign-on message, and prints the system prompt.

The system prompt is the A> on the screen. The A in A> indicates the current disk drive, the one to be used if you run a command or use a data file without giving a disk drive name. When you see the A>, you may execute any DOS command by typing the command's name.

Looking Back

PC DOS is the disk operating system of the entire IBM Personal Computer family. DOS is a highly functional, friendly, and fast operating system for PC*jr.* Knowing the commands, features, and functions of DOS makes a good foundation for understanding the programming languages and applications software—the subject of the next few chapters.

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Languages for PC*jr*

Programming languages act as translators. They translate our English-like program instructions into the binary ones and zeros that the CPU understands. Programming languages are the tools that transform a programmer's instructions into word-processing, spreadsheet, accounting, communications, engineering, entertainment, and other application programs.

Today, PC*jr* can run three different languages offered by IBM: the two levels of BASIC and the BASIC Compiler; Logo; and the IBM Macro Assembler. Although PC*jr* cannot use all of the languages that run on the PC and PC XT, PC*jr* can run many other programming languages not offered by IBM. The full number is unknown at this point, but a good guess would be over forty.

Why are there so many programming languages? There are so many because they serve distinct purposes. The languages are like tools. Each tool has one or more ideal uses; for example, a saw cuts wood, and a drill make holes. You can use a drill to cut wood or a screwdriver to chisel. The result may or may not be as satisfying as if the correct tool were used.

Any programming language can create almost any type of program, including another programming language. Each lan-

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guage has one or more ideal uses, which are based on proficiency time, program development time, execution speed, size of the developed program, nature of commands and adaptability, and other factors. These factors ultimately determine which tool (programming language) should be used for the task.

BASIC

BASIC is the most popular programming language. It runs on more computers than any other language in the world, it has the most versions and dialects, and it is used by a majority of the world's programming population. PC*jr* and the other IBM Personal Computers have a BASIC with more commands and statements than other versions.

BASIC is the acronym for "Beginner's All-purpose Symbolic Instruction Code." Developed at Dartmouth College in 1972, BASIC was meant to be a simple, number-oriented language for teaching students how to program computers. Bill Gates and Bill Allen wrote a version of this BASIC for the 8080 CPU in 1975, since dubbed BASIC-80 and MBASIC. BASIC-80 heralded the arrival of Microsoft, one of the two leaders in microcomputer language software. (Digital Research is the other.)

IBM BASIC is Microsoft's BASIC-86, the more powerful version of BASIC-80 written for the 8086 CPU. Microsoft BASIC is the most popular programming language. It runs on more than one and a half million different computers.

Like any other tool, BASIC has many advantages. It is easy to use, and its English-like commands and syntax are flexible and simple to remember. Programs can be constructed quickly. BASIC is also a forgiving language. It allows new names (called variables) for numbers or alphanumeric characters to be introduced almost anywhere in the program, and the language's way of phrasing commands (syntax) is more tolerant than that of COBOL, FORTRAN, or Pascal.

In BASIC each statement line has a number. The statements are executed in ascending order. BASIC can be told to GOTO another portion of the program and continue execution from that point. Program parts (subroutines) can be constructed and easily

executed by telling BASIC to perform the subroutine (GOSUB) and RETURN control to the main portion of the program when finished.

BASIC also has its weaknesses. Its many semicompatible versions make computerists groan. Beginning programmers whose first language is BASIC may have difficulty learning most other computer languages because BASIC encourages "sloppy" programming habits. It can also be difficult to maintain and change BASIC programs; additions may have undesirable side effects.

BASIC elicits two distinct reactions: people either swear "by it" or "at it." The original developers of the language are astounded by its growth and popularity. What comment best summarizes BASIC? It's "the quick and dirty way to get things done."

The IBM BASIC Programming Language

The IBM Personal Computer systems have four levels of BASIC. Three are interpreted BASIC: Cassette, Disk, and Advanced. The fourth level is compiled: the IBM (Microsoft) BASIC-86 Compiler. We'll explain the differences between interpreted and compiled languages later. Cassette BASIC is supplied with every Personal Computer system, including the XT. Disk and Advanced BASIC are supplied with PC DOS V1.1 or V2.0. The BASIC Compiler is an optional program.

PC*jr* has only three levels of BASIC: Cassette BASIC, Cartridge BASIC, and Compiled BASIC. There are some differences between the BASICs of PC*jr* and the rest of the IBM PC family. These differences will be explained in the following sections.

Cassette BASIC

In PC*jr*, Cassette BASIC resides in ROM. Cassette BASIC is identical to that in the PC and PC XT.

Cassette BASIC has 135 different commands and functions. It offers full numeric functions: addition, subtraction, multipli-

cation, division, power (xy), square root, exponential notation (X
*10ʸ), sine, cosine, tangent, and others, Cassette BASIC also
features extensive string (alphanumerics) handling functions:
LEFT$, RIGHT$, MID$, INKEY$, INSTR, etc. Cassette
BASIC also has program control statements (GOTO, GOSUB ...
RETURN, FOR ... NEXT, etc.), cassette storage statements for
programs and data, various text and color graphics statements,
and several uses for the special-function keys. Cassette BASIC is
a fully functional BASIC.

A handy feature of Cassette (and Cartridge) BASIC is that
program lines are edited on screen. You move the cursor
anywhere on the screen; change, delete, or insert characters; then
hit the enter key. The program line is then added or replaced. This
visual editing feature is identical to that of the Commodore
computer family, except that 255 characters are allowed per
program line for PC*jr* (80 characters for some Commodore
computers).

The Alt key has a new meaning in the interpreted BASICs. When
Alt and an appropriate letter are pressed, 22 BASIC key words
(commands) are "typed" onto the line. Command words like
PRINT, INPUT, or OPEN are entered with just two keystrokes.
The ten special-function keys (more in Cartridge BASIC) can be
redefined with up to fifteen characters each to supplement the Alt
key.

There are two reasons for the ROM-based Cassette BASIC. First,
because it's built in, Cassette BASIC can be used immediately
after you turn on the computer. Second, because the 32K Cassette
BASIC program is loaded into ROM rather than RAM (a
precious commodity on PC*jr*), more RAM is free for the user's
programs.

Disk, Advanced, and Cartridge BASIC

PC and PC XT use Disk and Advanced BASIC. PC*jr* uses
Cartridge BASIC. What is the difference?

Disk BASIC in the PC and PC XT extends the built-in Cassette
BASIC. Disk BASIC loads into RAM memory and adds the

commands for using the disk drive to store and retrieve programs and data. Commands to handle the hierarchical directories are also included. Some additional Disk BASIC commands also give you better control of the serial port.

Advanced BASIC is Disk BASIC, but the advanced version has even more commands to handle the use of graphics, sound, music, and the joystick. Advanced BASIC also has extra commands for better control of your programs as they execute. Like Disk BASIC, Advanced BASIC is loaded into RAM memory and extends the capability of Cassette BASIC.

Why does PC*jr* use a ROM cartridge for Disk or Advanced BASIC? Would it not be as easy to load these versions of BASIC into RAM?

Yes, you can load Disk or Advanced BASIC into RAM memory. However, this approach decreases the amount of free RAM by about 20K for Disk BASIC and at least 28K for Advanced BASIC. Since both Disk and Advanced BASIC need DOS (which uses 24K), a 64K PC*jr* does not have enough RAM to use either Disk or Advanced BASIC. On 128K PC*jr*s, only 46K will be left over to run programs.

Cartridge BASIC was produced for PC*jr* for two reasons. The first is PC*jr*'s limited RAM memory. If Advanced BASIC were not in ROM (which is what the cartridge really is), you would not be able to run large BASIC programs. The 32K Cartridge BASIC leaves RAM free for your program and data. The second reason for Cartridge BASIC is that not all PC*jr* owners will buy the enhanced unit. Many will start with just the cassette version. The only way that these buyers can use the features of the Advanced BASIC is to put BASIC in a cartridge that can be plugged in to one of the cartridge slots. The decision to market a separate ROM cartridge for BASIC is a good one. The 32K Cartridge BASIC can be used on the entry PC*jr* and does not occupy any RAM memory in the enhanced PC*jr*.

Although the BASIC programming language does not take up any RAM memory, BASIC does need some RAM to function. Internally, BASIC needs RAM to keep track of the program as it executes; and to use the serial port, printer, and other items. BASIC does "steal" some RAM memory.

Is Cartridge BASIC the same as Advanced BASIC? No, Cartridge BASIC is better. It is 32K big, compared to 25K of Advanced BASIC. The extra 7K hold many new commands for video graphics and sound.

To use Cartridge BASIC on PC*jr*s without a disk drive, you plug the cartridge into the slot, then turn the computer on. Cartridge (rather than Cassette) BASIC is activated. You may also plug the cartridge into the slot after you turn on the machine.

If you have a disk drive, you type the command BASIC or BASICA to run Cartridge. One or more optional "switches" may be specified when you invoke Cartridge BASIC. These switches can decrease or, most often, increase the RAM space used by BASIC. The options include the following: the size of the communications buffer(s); the maximum number of open files; BASIC's (not PC DOS') disk buffer size; the amount of reserved workspace (for machine-language programs, etc.); and the use of single- or double-precision transcendentals. Several of these terms will be discussed later in this chapter.

What Is in Cartridge BASIC?

The following list provides a brief preview of what is in Cartridge BASIC:

- Commands to set and use the serial port and Internal Modem for communications
- Commands to set and use the serial port with devices that need hardware handshaking
- More commands for using the joystick
- More commands for using and controlling color graphics
- More commands for using and controlling sound and music
- Double-precision transcendentals
- Commands for using hierarchical directories and the disk drive
- More commands for controlling the flow of programs
- Commands for controlling a program when a hardware event takes place

These functions and features of Cartridge BASIC are impressive.

Following is a discussion of some of its commands.

Cartridge BASIC has several commands to set up and use the serial port with a modem or printer. Some printers use different RS-232 lines to coordinate the moving of information between the computer and the printer. Commands in Cartridge BASIC allow you to tell PC*jr* what serial lines should be used for this "hardware handshaking."

Also available are commands to set the baud rate, parity, and other characteristics of the serial port. Additionally, a built-in terminal mode lets PC*jr* act as a terminal when talking to other computers.

Cartridge BASIC supplies a powerful statement to Cassette BASIC. The statement is ON event. The event can be activity on the serial port, the pressing of a special-function key, use of a light pen or joystick, or an elapsed amount of time. When the event occurs, BASIC jumps to the indicated part of the program. These statements are called *event-trapping* statements. You give the ON event statement in your program the line number of the part of the program you want BASIC to execute when the event occurs. Regardless of what program lines BASIC is executing when the event happens, BASIC unconditionally jumps to the line number holding the ON event statement. Programs can therefore handle joystick, communication, special-function keys, light pen, or timed events at any time. This feature offers a considerable improvement over BASICs that do not have event-trapping ability.

Color graphics is a major feature of PC*jr*. Cartridge BASIC has many commands (more powerful than in Advanced BASIC) to handle color graphics. We'll discuss BASIC and color graphics later in this chapter.

PC*jr* has better sound capability than that of the PC or PC XT. The internal speaker of the PC or PC XT can play two notes at a time with Advanced BASIC. PC*jr*'s sound circuits can play three notes at once. Cartridge BASIC has several commands for sound and music. One of the new commands is NOISE, a statement that

lets you generate white noise on a TV's monitor or an amplifier's speaker.

A command borrowed from Advanced BASIC is PLAY. You give the PLAY command a string of characters. These characters control which of the three voices is to be used, as well as sharps and flats, octaves, tempo, key, and length of the note: normal (7/8), legato (4/4 or full period), or staccato (3/4).

Most of the routines for using the disk drive in storing and retrieving BASIC programs and data are built into Cartridge BASIC. Included are the hierarchical directories of PC DOS and I/O redirection. BASIC does not actually store and recall programs and data from the disk. BASIC calls on PC DOS to do the actual work.

The significance of double-precision transcendentals requires an explanation. BASIC uses 5 bytes to store a normal number. This is a *single-precision* number, and it can have 7 digits. *Double-precision* numbers occupy 9 bytes of memory and have 14 digits.

Transcendentals are numbers that cannot be expressed in a finite number of arithmetic operations. In math, transcendentals are part of the set of irrational numbers. BASIC has transcendentals for square roots, sine, cosine, tangent, arc tangent, logarithm, and antilogarithm. Normally, transcendentals are single-precision 7-digit numbers; however, single-precision Cartridge BASIC allows the 14-digit variety.

The Video Display Modes

Before completing the discussion of BASIC, you should know more about the video display, graphics, and the commands that BASIC uses to control graphics.

There are various modes of display for the video screen. The major modes are textual display and graphics. The IBM name for text display is alphanumeric or *A/N* mode. The IBM name for graphics is All-Points Addressable, or APA mode. Each mode has several variations that we'll call submodes.

The A/N submodes cover the number of characters displayed per line and choice of black and white (monochrome) or color display.

The three characters-per-line submodes are 20, 40, and 80. The 40- or 80-column modes are identical to those in PC DOS. The new 20-column mode is unique to BASIC and PC*jr*.

You may not have noticed that several screens in memory are possible: eight 40-characters-per-line or four 80-characters-per-line. A command in BASIC controls the display. The advantage of having several screens is that one is displayed while another is being built: the "switch in" is so fast that information seems to appear out of nowhere.

The characters in A/N mode may be shown in monochrome or color. It does not matter what type of monitor you use. The choice of whether to display colors originates inside PC*jr*. With the monochrome submode, PC*jr* kills the color signal, and the text displays in black and white; the characters may be shown in normal video (white on black), blinking on and off; reverse video (black characters on a white background); or high brightness (high intensity). Blinking works with either normal or reverse video characters.

Using the color submode allows you to display the text and background in 8 different colors. By using the intensity signal, 16 different colors are possible. Whether they will be visible depends on the TV or monitor you use. Some TVs and monitors will not be able to display all 16.

All-Points Addressable is the graphics mode. "All-points addressable" means you can control the turning on or off of an individual point on the video screen. That is what computer graphics really is. APA mode has three submodes based on the number of pixels. A *pixel* is the basic unit that you can control on the screen. The three submodes are low-, medium-, and high-resolution.

The low-resolution version splits the video screen into 160 pixels horizontally and 100 pixels vertically. Each pixel is 2 dots high by 2 dots wide and can be one of 16 different colors.

Table 5.1
Colors Available for Various Video Modes

#	Name	A/N or Low-Res	Available in Medium-Res Foreground	Background	High-Res
0.	Black	*	*	*	*
1.	Blue	*		*	
2.	Green	*		*	
3.	Cyan	*	*	*	
4.	Red	*	*	*	
5.	Magenta	*	*	*	
6.	Brown	*	*	*	
7.	Light Gray	*		*	
8.	Dark Gray	*		*	
9.	Light Blue	*		*	
10.	Light Green	*		*	
11.	Light Cyan	*		*	
12.	Light Red	*		*	
13.	Light Magenta	*		*	
14.	Yellow	*		*	
15.	White	*	*	*	*

Note: colors 8 through 15 may be available on some TVs or monitors.

The medium-resolution submode uses 320 pixels horizontally by 200 pixels vertically. The pixels are only one dot large. Two sets of foreground colors exist. One set uses cyan, magenta, and white; the other green, red, and brown. Only one set may be used at a time. However, the background may be any color. Thus, four colors may be used at once, three from the chosen set and any one for background.

The high-resolution submode divides the screen into 640 horizontal by 200 vertical pixels. Like the medium-resolution version, a pixel is one dot big. Two colors are used: white and black.

If you have been wondering why 16K is devoted to the video screen, the medium- and high-resolution submodes provide the answer. Each pixel on the medium-resolution screen takes two

bits. With two bits, four choices are possible. This is why only one of three colors, with a fourth for background, can be used. In high-resolution graphics, each pixel uses a memory location.

The memory needed for medium-resolution graphics is determined by the following:

320	horizontal pixels
x 200	vertical pixels
64,000	pixels
x 2	bits per pixel
128,000	bits
/ 8	bits per byte
16,000	bytes of RAM (or just under 16K)

High-resolution graphics need 640 x 200 bits of RAM (a pixel takes one bit), for a total of 128,000 bits or 16,000 bytes. Why the video screen needs 16K of memory is evident.

The display characteristics of PC*jr* are identical to those of the Color/Graphics Adapter used in the PC and PC XT, with two exceptions. The 20-characters-per-line and low-resolution (160 x 100) submodes are not supported by the PC or PC XT. The PC*jr* is the only member of the PC family that can use these two submodes immediately without additional software.

Cartridge BASIC and the Display

Cartridge BASIC uses some of the commands and statements of Advanced BASIC. Cartridge BASIC also adds some new commands and extends some old ones. Following is a summary of some of the graphics commands of Cartridge BASIC.

CLEAR is a new command that is available only for Cartridge BASIC. CLEAR sets the size of the video buffer.

CIRCLE is an established statement that draws a complete circle (or any part of one) on the video screen. You can specify the circle's size and color and the location of its center.

New options are provided in Cartridge BASIC for the COLOR command, which sets the foreground and background colors used in all video modes (A/N and APA).

DRAW makes a shape on the video screen, based on an alphanumeric string. Most BASIC graphics commands work on a coordinate system. You give X (horizontal) and Y (vertical) coordinates. DRAW is one of the commands that lets you draw shapes based on a string rather than individual commands for drawing one point at a time.

The GET and PUT commands work with a numeric array. GET looks at the information on the graphics screen and pops this information, in the form of numbers, into the array. PUT does the reverse: it translates a numeric array into graphics on the screen.

PAINT is a command that is used to fill rapidly an area of the screen with a color, instead of using point-by-point plot statements.

PALETTE and PALETTE USING are two commands unique to the new Cartridge BASIC. With these commands, you can select the colors you want without using the less flexible COLOR command.

PCOPY, also new, copies the contents of one video screen onto another. This command is mainly used with the A/N mode.

PMAP, VIEW, and WINDOW are commands that control the coordinate system used when plotting. The normal scale puts coordinates 0,0 at the upper left-hand side of the screen. These three commands let you alter the position of 0,0, thereby turning the number system into a "world coordinate" plotting. For instance, it is easier to draw a plot of positive and negative numbers if 0,0 is at the center of the screen.

The SCREEN command has also been expanded to handle the new 20-column A/N mode.

Summing Up Cartridge BASIC

Cartridge BASIC is a programmer's delight. With Cassette BASIC as its foundation, Cartridge BASIC pushes the total number of BASIC commands, functions, and statements over 200—more than any other computer. The event-trapping, music support, disk drives, transcendentals, and other features make Advanced BASIC a highly functional programming language.

The way in which BASIC supports colored text and graphics makes these features easy to use.

BASIC and the Compiler

Before we discuss the BASIC Compiler, you should know what the differences are between interpreted and compiled languages.

Interpreters

Most BASICs, including Cassette and Cartridge, are *interpreted*. The BASIC program translates each encountered program line into the appropriate instructions for the CPU. Language interpreters are like United Nations interpreters. They act as go-betweens, on a line-by-line basis, for the program and the CPU. Interpreted languages make programs easy to develop. You write a section, try it out, then change it at any time. You can easily stop the program, examine its progress, and, in most cases, continue running it. Interpreted programs are also more compact and require less disk space for storage. For these reasons, interpreted languages like BASIC are ideal for learning how to program and for writing programs quickly.

Compilers

Languages can also work as *compilers*. The English-like program statements (source code) are transformed into instructions that the computer's CPU can directly execute (machine-language object code). A process called linking, however, is usually required to finish the program. If languages such as Cassette and Cartridge BASIC are like UN interpreters, compilers are like the Berlitz™ School of Languages. Compilers "teach" (change) the program to speak the native language of the CPU.

Compiled programs are more difficult to develop. If you make one mistake in a statement, you must correct the source code by using a separate text editor to recompile the source code, relink it, and retest the program. Much more work is involved than in interpreted languages, where you never exit the language to correct a mistake or test a program. In addition, compiled programs generally use more disk space for storage than the interpreted kind.

The advantage to compiled programs is that they execute many times faster than the interpreted variety. These programs are faster because the CPU executes just the program, not the interpreter and the program. Another advantage is their protection of the source code. Once a program has been transformed by the compiler into object code, reconstructing the programming statements is difficult, if not impossible. Compiling protects against somebody trying to steal any ingenious or unique programming methods an author has created. (An appropriate description is "source code protection.")

The BASIC Compiler

The optional BASIC Compiler greatly improves the execution speed of BASIC programs. Those written in Cassette or Cartridge BASIC are transformed into directly executable machine language. The program must be stored in an ASCII format. If the program was developed with the Cartridge BASIC interpreters, it must be saved with the ,*A* (ASCII) option.

The BASIC Compiler has many of the features found in the Disk and Advanced BASIC of PC and Cartridge BASIC of PC*jr*. Unfortunately, not all features of Cartridge BASIC, and none of DOS V2.1, are in the BASIC Compiler. Therefore, not all programs written on PC*jr* can be compiled.

The beauty of the BASIC Compiler is that programs are developed in interpreted BASIC. When the program is debugged and is working satisfactorily, you compile the program. The ease of interpreted BASIC and the speed and performance of a compiled program are the results—which is having the best of two worlds.

The improvement in speed because of compiling varies. If your program extensively manipulates strings and real numbers, the compiled program will run two to four times faster. With mostly integer numbers, your compiled programs may run in one-tenth the time as an interpreted program. Speed improvement averages between 200% and 600%. When a program is compiled, the source code and any trade secrets in the program are protected.

The BASIC Compiler and PC*jr*

The BASIC Compiler is actually a set of programs and libraries. BASCOM.COM is the BASIC Compiler itself. A library of BASIC subroutines (BASCOM.LIB), a run-time support library (BASRUN.LIB), and a run-time package (BASRUN.EXE) are also provided. The library is a set of proven subroutines. The run-time support and run-time package are additional library sets, which are joined with a program and the BASIC subroutine library to create the finished program.

To compile a program, you run the BASCOM.COM program. Then you must join the compiled program with the appropriate library of subroutines by running PC DOS's LINK. If you link the BASCOM.LIB library file with your program, the resulting file produced by LINK is finished and free standing. This program can be run by simply typing its name.

A program linked with the BASRUN.LIB library of subroutines is not free standing. The BASIC Compiler Run-time module, BASRUN.EXE, is necessary to execute the linked program. You run BASRUN.EXE with the name of your program. BAS-RUN.EXE loads it into memory and provides the necessary subroutines.

Why are there two different libraries of subroutines? Programs linked with BASCOM.LIB are bigger and require more disk space to store. You must also pay a royalty to IBM if you sell a program that uses BASCOM.LIB. Programs linked with BASRUN.LIB are smaller and need less disk space. This is because each program uses the one set of subroutines in the BASIC Compiler Run-time module. You can sell a program without the run-time module and not pay a royalty to IBM. However, the purchase of either the BASIC Compiler or the run-time module is necessary to use the programs.

Because of the limited resources of PC*jr*, (one 360K disk drive and only 88K of RAM memory), compilation and linkage of large programs may not be possible on this computer. Unfortunately, there is no good way to judge what makes a "large" program. A 4K Cartridge BASIC program might compile into a 28K machine-language program. It is difficult to foresee how big an

interpreted program will become when it is compiled. If the program is too big, it may be compiled on a suitably equipped PC or PC XT. The same BASIC Compiler runs on all three computers.

Despite these limitations, the rewards of the BASIC Compiler are great. Many, but not all, of the Cartridge BASIC features are available. Programs are directly executed from PC DOS, and the BASIC interpreters are not required. The main advantage of the BASIC compiler is that a programmer can use the friendly, easy-to-develop resources of interpreted BASIC. When a program is perfected, it is compiled and it gains the advantages of all compiler-based languages: a significant increase in speed and protection for the program's source code. The BASIC Compiler gives the programmer the best of both interpreted and compiled programming worlds.

Looking Back at BASIC

Although the implementation of the BASIC interpreters and Compiler is somewhat unique to PC*jr*, Microsoft BASIC is still what the computer uses. You can, therefore, type most programs written for any version of Microsoft BASIC into PC*jr* and execute them with little or no modification. The majority of the modifications will center on the video display (CLS, LOCATE, CRSLIN, and color graphics commands) and commands that involve equipment that is unique to PC*jr* (communications ports, the special-function keys, etc.).

In spite of the limitations mentioned earlier, BASIC is an excellent, general-purpose programming language whose supporters are found in the personal, educational, entertainment, and business fields. This powerful language evolved from the many generations of Microsoft BASIC (starting in 1975). BASIC is not only a powerful language, but also a friendly one.

Logo

A new language, which originated in the field of artificial intelligence, has recently emerged. This language is called Logo. Like BASIC, Logo is an ideal language for beginning programmers. However, there are major differences between Logo and BASIC.

Structured programming

One way to group programming languages is according to how they interact with the program, interpreters, and compilers. Another classification method involves the way commands and statements are phrased or structured. *Structured* languages demand that certain information be presented at particular points in a program. This information varies between languages. Generally, language compilers need more of such particular information than interpreted languages. The kind of information that structured languages might possibly need includes: the name of a variable and what it will contain before it is used; whether the variable is valid for the entire program or for only a section; whether a subroutine will request information (input) or display information (output); and/or what information the subroutine (usually called a function or procedure) will produce.

Programs written in a structured language use a building-block approach to writing. Subroutines, functions, procedures, or blocks are usually developed to handle one purpose. The blocks combine to build the majority of the program.

Structured programming languages force you to follow certain procedures. These usually enforce good programming techniques, which also increase program readability and clarity. Program maintenance, adapting and changing a program, is usually easier to do with structured programs.

Once you have learned one structured programming language, it is usually easier to learn another. However, a person who learns a nonstructured language first usually has more difficulty in learning a structured language, which requires dealing with many new concepts and procedures for the first time. Most business and commercial computers use COBOL, RPG II, or C—all structured languages. Chances for finding employment in a computer-programming-related area are greater with knowledge of a similar, structured language.

Writing in a *nonstructured* language is easier. Less forethought and planning are required. New names for variables, and for their type and size, can occur anywhere in the program, provided that these statements are executed in the proper order. Nonstructured

languages make extensive use of GOTO and GOSUB statements, casually transferring the flow of the program among its various parts.

You might have guessed that BASIC is a nonstructured language. Its main strengths lie in the power of its commands and its forgiving nature. BASIC is good for those who want to learn only one programming language.

IBM's Logo

IBM's Logo comes from Logo Computer Systems, Inc. The Logo language was developed initially as part of a National Science Foundation grant in 1968. Since then, most of the language's improvements have come from the Massachusetts Institute of Technology (MIT), the University of Edinburgh in Scotland, and Logo Systems Limited in Canada.

Logo is a structured, interpreted language. Such a combination is rare. Programs in Logo are organized into basic blocks, called *procedures*. As with Cassette and Cartridge BASIC, editing and executing programs are done interactively; programs may be constructed, tested, altered, and executed again. Unlike many other structured languages, the variables used in a program do not need to be declared "up front." For these reasons, Logo has the same forgiving nature as BASIC.

Logo is a direct "descendant" of the LISP programming language. Both languages have been used extensively in artificial intelligence work. Both are also "natural" languages, which means that programs are constructed in a manner similar to the way people solve problems. Using this approach, the educational field is turning to Logo to teach children programming. The language runs on computers like the Apple IIe, the TI 99/4A, and the TRS-80 Color Computer. PC*jr* has something in common with these three computers: all have color graphics. One of Logo's major features is its unique way of handling color graphics. BASIC, and many other languages, plot one graphic pixel at a time using X, Y coordinates. Logo uses turtlegraphics.

Turtlegraphics uses an imaginary turtle whose tail contains colors. The turtle is commanded to rotate a set number of degrees

(based on a 360° circle), move a set distance, drop its tail and paint, or walk with its tail up and not leave a trace. The turtle can be picked up and placed anywhere on the screen. The concept of turtlegraphics is simple to learn. It makes graphics easy to manipulate. Instead of translating a shape into a series of points, you move the turtle to follow the shape you wish to draw. Children can grasp the idea of moving the turtle much faster than learning X, Y coordinates.

Turtlegraphics "gets under a child's skin," and makes the child want to learn more about computers. Why? Children like visually oriented feedback. The activity at your local game arcade proves this. Because they can easily manipulate graphics on the video screen, children want to learn how to use computer programs. However, don't get the impression that Logo is just for children. Logo is for everyone.

Another of the language's benefits is its method of handling collections of data. Instead of using one- or multi-dimensional arrays like BASIC, Logo organizes information into lists (just as humans do) and provides many powerful commands for extracting the information in the lists.

A feature of the Logo language is recursion. *Recursion* means that a procedure uses itself as a subroutine. Don't be concerned about recursion until you can use a programming language that allows this feature. BASIC does not. If you begin using recursion, however, you will be surprised by how much easier it is to program.

In Logo, you do not give a computer instructions; you give it "descriptions." This distinction separates Logo from other languages, including BASIC. Logo is a language that works the way we do, with lists, procedures, and recursions. The way the procedures are built and used makes the computer more intelligent and more capable of handling new tasks.

Logo's only major flaw involves disk storage. The current standard for the Logo language does not include how data should be stored and retrieved from the disk drive. With current Logo, all the data in the computer is loaded and saved at one time. You cannot selectively (randomly) access information within a file. This limitation, however, may be solved in the next year.

Assemblers

An *assembler* is a software program that translates a narrow range of commands, called *mnemonics,* into instructions that are directly understood by the computer's CPU. Programming in assembly language is just two steps away from using the native on-and-off bits the CPU executes.

The next to the last step is *hand coding,* the direct manual entry of hexadecimal, base 16, values that represent the commands and data for the CPU commands. The final step is informally called *toggling*—toggle switches with l.e.d.lights, one for each bit, on the front panel of the computer are manually turned on or off to enter an instruction for the CPU. Toggling was popular in the microcomputer's "home brew" kit-construction infancy. Hand coding can be done with PC DOS's DEBUG; you can't toggle any switches with PC*jr*. Fortunately, more productive software tools, such as assemblers and debuggers, have almost eliminated both procedures on most microcomputers.

Assembly language programming is intended for those who are interested in writing programs that require little overhead, provide better performance, and use features that cannot be accessed through a high-level programming language.

Assembly language programs occupy the smallest amount of RAM space possible. High-level interpreter languages like BASIC may have small programs, but together the language and the programs usually require more total RAM space. If your program does not use a function or feature of BASIC, the BASIC interpreter does not have a way to "shed" these functions and free the RAM space for program use. This limitation is true of most interpreted languages, including Logo. High-level, compiler-based languages like the BASIC Compiler have a similar problem, but to a lesser degree. Assembly language programs, however, do not have this problem. Much overhead is eliminated because a language interpreter is not kept in memory to run the program, and the only subroutines included in the programs are those written by the programmer, who has complete control of the program in assembly language.

In some programs, speed is an important consideration. In such cases, programs or subroutines are usually written in assembly language. Many word-processing, data base management, and communications programs are written in assembler for these reasons. If program size and speed are primary concerns, assembly language is the right choice.

Assembly language is the most difficult language to learn, and assembly-language programs are the hardest to maintain. The programmer is responsible for keeping track of every machine location the program uses. Unlike high-level languages, which relieve the programmer of many mundane chores, the programmer does most of the work. The commands do not resemble English; they are mainly acronyms and abbreviations. One program mistake can crash memory locations, or disks, or the entire program itself. The very low level of conversation between the programmer and computer requires major work in the creation and maintenance of assembler programs. Typically, assembler programs take 200 to 2000 percent more time to develop than high-level language versions.

Macro Assembler

The IBM Relocatable Macro Assembler is the powerful Microsoft assembler for 8086 or 8088 CPUs. MASM, its on-disk name, provides many aids for fast and efficient assembly language programs. MASM also assembles instructions for the 8087 numeric coprocessor. This concerns PC or PC XT owners more because PC*jr* cannot use this chip. If you want to write in assembly language, you will need to buy the Macro Assembler. An assembler is not provided with PC DOS.

With the Macro Assembler, subroutines consisting of hundreds of program lines can be stored and later invoked by one command, the macro instruction. Complete cross-references of the program with the commands, ops and psuedo ops, the produced 8086 or 8087 instructions, and used memory locations are generated, unless otherwise stated.

The Macro Assembler can handle many normal CPU commands called *ops* (shorthand for *op*erands, the mnemonic instructions)

and many *pseudo ops* (instructions translated by the assembler into appropriate machine-language statements or commands for the assembler). Pseudo-ops usually control program printing, the interpretation of commands (for example, IF ... THEN ... ELSE statements), the beginning memory location for the program, and other elements. Macros fall into the category of pseudo ops.

Like the BASIC Compiler, you'll need PC DOS and 128K of RAM to use the MASM. Most, but not all, programs can be assembled and linked on PCjr's single disk drive. However, using MASM will be clumsy as you must frequently swap diskettes in and out of the single disk drive while producing your program.

Other Languages

What other languages will run on PCjr? There are over sixty versions of twelve different languages that run on the PC and PC XT. These include more versions of BASIC, Logo, and assemblers, Ada, C, COBOL, Forth, FORTRAN, Lisp, Pascal, RPG, and others. Not all of these languages will be available to PCjr.

The restriction is not memory size but disk drive size. Many of these languages need two disk drives to compile programs. Since the native enhanced PCjr has only one drive, some programming languages will be excluded. However, expect many publishers of programming languages to move their products to PCjr if they can.

Looking Back at Languages

Today, PCjr has three languages: BASIC in three versions, Logo, and the Macro Assembler. (If you want your program to be as small and as speedy as possible, the IBM Macro Assembler is the only assembler you can use on PCjr.) Most people will find that the Cassette/Cartridge BASIC combination is the only program language they will ever need. PCjr's BASIC is very powerful, more so than the current BASIC for the PC and PC XT. The BASIC Compiler compliments Cassette and Cartridge BASIC and turns interpreted programs into high-speed machine-language programs.

Logo, a newcomer to the PC family and also popular in the educational field, is gaining support among beginning and advanced programmers as well. With excellent graphics and list-processing capability, Logo will find many "converts" in the next year.

BASIC and Logo are two excellent languages for beginners. However, if you don't want to program or do not have the time to write very extensive programs, IBM sells programs for PC*jr* for home management, education, and entertainment. The next three chapters cover products for home, school, and recreation.

PC*jr* for Personal
Management

In Chapter 1 we saw that applications software is the tool you use to make a computer do what you want it to do. As the term implies, an application program gives the computer the instructions it needs to perform a particular application. For example, word-processing software tells the computer how to be a word processor.

Although prospective computer users often concentrate on hardware, which is more tangible (and more costly) than software, it is software that really determines the usefulness of a computer. Without applications software, your PC*jr* would be just an expensive box filled with silicon chips. The power of a computer lies in its applications software. Because applications software determines the capabilities of the computer system, the next three chapters are devoted to this subject.

PC*jr*'s applications software library can be divided into three groups: personal management programs, educational programs, and entertainment programs. In this chapter we'll cover PC*jr*'s *personal management* software.

Financial Programs

PCjr offers three financial programs. Two, VisiCalc and Multi-plan, are electronic spreadsheets. The third, Home Budget, *jr*, is a personal financial management tool.

VisiCalc

Application: Electronic Spreadsheet
Original publisher: VisiCorp
Price: $200
System Requirements: Disk drive
                            DOS 2.1
                            (May require 64K and Display
                            Option to make full use of the
                            program's capabilities)

VisiCalc is the most popular business software program ever published. As the first electronic spreadsheet, VisiCalc defined the concept for those that followed. The primary application for VisiCalc is financial planning and analysis. The program offers a variety of built-in arithmetic, financial, trigonometric, and logical functions. VisiCalc also includes commands that insert, delete, and move rows and columns in the worksheet. These features make setting up a new sheet, or modifying an old one a simple task.

Spreadsheet Basics

VisiCalc (like other electronic spreadsheets) is an electronic replacement for traditional financial modeling tools: the accountant's columnar pad, pencil, and calculator. In some ways, electronic spreadsheets are to those tools what word processors are to typewriters. Spreadsheet programs offer dramatic improvements in the ease of setting up and using financial models.

Perhaps VisiCalc's greatest feature is that it is *visual* software. The program emulates an accountant's columnar pad, except that it is much larger. Like many electronic spreadsheets, the VisiCalc sheet has 254 rows and 64 columns. Each row is assigned a number and each column, a letter. The intersections of the rows and columns are called *cells*. They are identified by their row-column coordinates (for example, cell A15 or cell X55).
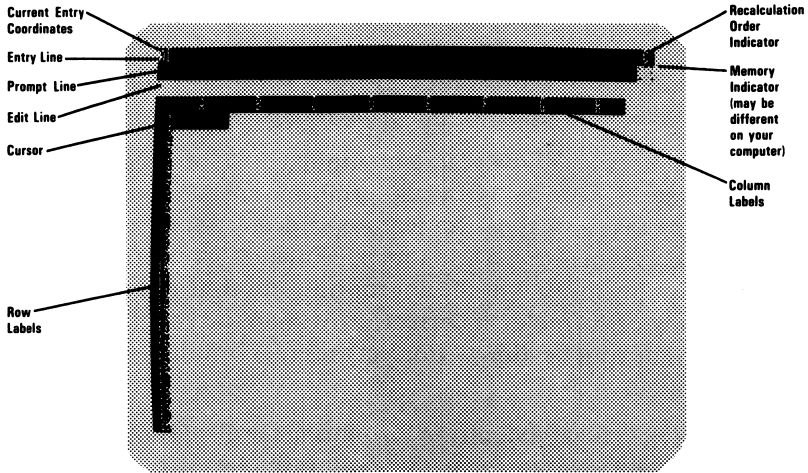
Figure 6.1
Basic VisiCalc Worksheet

These cells can be filled with three kinds of information: text (or labels), numbers and mathematical formulas, and special spreadsheet functions. A *cursor* allows the user to write information into the cells much as a pencil lets you write on a piece of paper.

VisiCalc allows you to create mathematical relationships between cells. For example, if a cell named C1 contains the formula

    C1 = A1+B1

C1 will display the sum of the contents of cells A1 and B1. The cell references serve as *variables* in the equation. No matter what numbers are enterd in A1 and B1, cell C1 will always return their sum. Of course, spreadsheet formulas can be much more complex than this simple example.

Functions are shortcuts that help the user perform common mathematical computations with a minimum of typing. VisiCalc offers mathematical functions (like @Sum), statistical functions (like MAX, @MIN, and @AVERAGE), financial functions (likie Net Present Value), and special functions (like @IF). Newer spreadsheets, such as Multiplan, include more advanced functions.

VisiCalc offers advantages at every phase of building and using a model. Because spreadsheet programs hold the model in the computer's memory while it is being built, the user is not bound by the physical limitations of the printed page.

VisiCalc *commands* allow you to manipulate the information in the spreadsheet. Do some of your formulas repeat across time? Use the spreadsheet's *replicate* feature to project your assumptions quickly from one cell to another. Did you forget a row or a column? Simply *insert* it at the appropriate point. Is one of your assumptions or formulas incorrect, or is there a typographical error in one of your headings? Correct the error instantly with the *edit* command.

VisiCalc offers great flexibility in formatting the display of data in the worksheet. Users can format *globally* (all cells at once) or one cell at time. Formats include integer, dollars and cents, left-justified, right-justified, and graph.

The act of building a model on a spreadsheet defines all the mathematical relationships in the model. Until you decide to change them, every sum, product, division, subtraction, average, and net present value will remain the same. Every time you enter data into the model, computations will be calculated at your command, with no effort on your part. All computations will be correct—spreadsheets don't make math errors. When you decide to use the same model again, the formulas will still be set, ready to calculate at your command.

Even more important, spreadsheet software like VisiCalc allows you to play "What if . . . ?" with your model after it has been developed. If you use paper, pencil, and a calculator to build your models, each change will require recalculating every relationship in the model. If the model has 100 formulas and you change the first one, you must make 100 calculations to flow the change through the entire model. If you use a spreadsheet, the same change requires only the pressing of a few keys; the program does the rest. This capability makes possible extensive "what if" analysis.

VisiCalc on PC*jr*

The version of VisiCalc implemented on the PC*jr* is the same as most other versions of VisiCalc. The only exceptions are a few features that result from the fundamental characteristics of the PC*jr* (like the PC*jr* keyboard).

You need 128K of RAM to use Visicalc on PC*jr*. With this much memory, you'll have enough space to create fairly large models. For extremely large models, you may want to consider an IBM PC or other high-memory computer because VisiCalc models can really eat up RAM.

Enhancements

VisiCalc continues to be enhanced by the original publisher, VisiCorp®, and has been converted for many popular personal computers. Two of the newest versions of VisiCalc are the VisiCalc Advanced Version and VisiCalc IV.

VisiCorp released VisiCalc Advanced Version to compete with new spreadsheets like Multiplan. Unfortunately, the Advanced Version is not available for PC*jr* because the program requires more than 128K of RAM.

VisiCalc IV integrates a program called StretchCalc™ into the basic VisiCalc program. StretchCalc offers several enhancements, including fairly advanced business graphics. VisiCalc IV is designed to compete with 1-2-3 and other integrated programs. Like the Advanced Version, though, VisiCalc IV requires too much memory to run on PC*jr*.

After many years at the top of the bestseller list, VisiCalc has fallen from its spot because of competition from newer programs like Multiplan. Since VisiCalc was the first spreadsheet program, and thus the "one to beat," most of its outstanding features have been copied extensively.

VisiCalc is still the standard by which all spreadsheets are measured. Although most of what is said about VisiCalc can be said about the other programs, most of these things were said first about VisiCalc. An excellent spreadsheeting tool, VisiCalc is a good choice for home financial planning.

Multiplan

Application:	Electronic Spreadsheet
Original Publisher:	Microsoft Corporation
Price:	$250
System Requirements:	Disk drive
	DOS 2.1
	64K Memory and Display Option

Multiplan is one of the new-generation electronic spreadsheets. It offers all the functions, formats, and commands of the first-generation spreadsheets like VisiCalc, plus several exciting new features.

The experienced VisiCalc or SuperCalc user will have no problem recognizing most of the features of Multiplan. In its basic spreadsheeting capability, Multiplan is similar to VisiCalc. Like VisiCalc, Multiplan uses a 255-row by 63-column spreadsheet; but Multiplan numbers both rows and columns in the sheet. Thus, the VisiCalc cell reference A1 becomes cell r1c1 in Multiplan.

Multiplan's new method of cell reference and unique functions require some getting used to, but Microsoft has shown concern for prior users of VisiCalc by including a *file import* feature that will read a VisiCalc file directly into Multiplan.

Probably the hardest thing for an experienced spreadsheeter to adjust to is Multiplan's elimination of the / key for initiating commands. Many VisiCalc or SuperCalc users will continue to reach for that key for a while after converting to Multiplan.

Multiplan goes well beyond the first-generation electronic spreadsheets by offering several new arithmetic, logical, and special functions. One is STDEV, which computes standard deviations. A new financial function, IRR, computes the internal rate of return.

The text functions of Multiplan are similar to those of Microsoft's biggest-selling product, the Microsoft BASIC language. (Microsoft BASIC is also the biggest-selling microcomputer language in the world and is the basis for IBM PC*jr* BASIC.) The FIXED function converts a numeric entry to a text entry. Conversely, the VALUE function converts text entries into numeric entries.
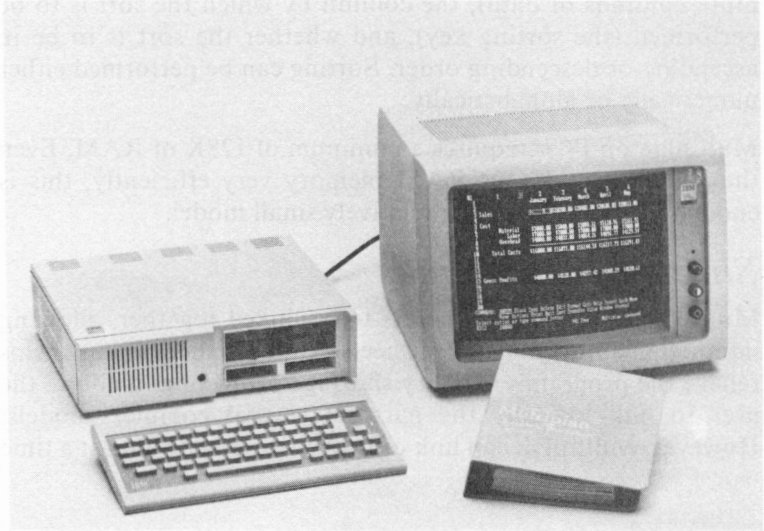
Pictured is a PC*jr with an IBM Color Display. The picture on the screen is from Multiplan. (Photo Courtesy International Business Machines)*

Converted numbers can be concatenated (linked together) with text to embed numerical data in the middle of sentences. The function MID considers either text or a cell reference containing text and returns the specified portion of the total text string. Another text function, LN, returns the number of characters in a cell.

Like other advanced spreadsheets, Multiplan allows areas inside the sheet to be referred to by user-specified names. A named range can be a single cell or a rectangular area of any size. The names can describe the contents of the cell or the range being named, for example, "SALES" or "TOTAL EMPLOYEES."

Multiplan's format command provides extensive options for the formatting of text or numbers within a cell. Text may be centered or left- or right-justified within a cell. Numbers may have a fixed number of significant digits. The user has a wide range of formats available, including floating dollar signs, commas, asterisks, exponents, integers, and percentages.

Multiplan can sort columns and tables of data within the spreadsheet. The user must specify the range to be sorted (one or

more columns of data), the column by which the sort is to be performed (the sorting key), and whether the sort is to be in ascending or descending order. Sorting can be performed either numerically or alphabetically.

Multiplan on PC*jr* requires a minimum of 128K of RAM. Even though Multiplan uses RAM memory very efficiently, this is enough memory for only a relatively small model.

Sheet-to-Sheet Links

Multiplan allows several sheets to be linked together, allowing interaction among the linked sheets. Multiple sheet linking helps relieve the program's memory shortage problem and allows the user to link logically the parts of several complex models. However, Multiplan can link only one single-cell value at a time
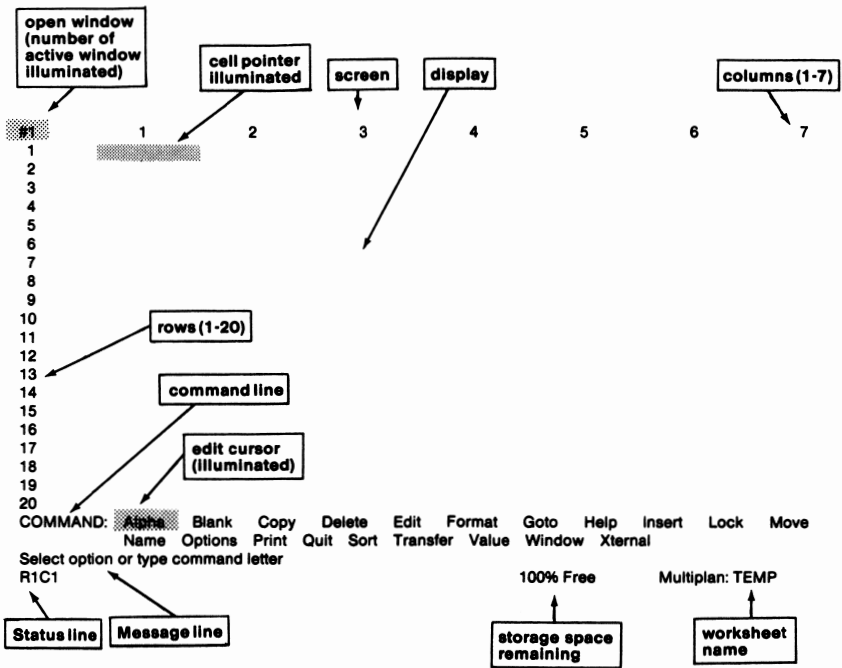
Figure 6.2
The Multiplan Worksheet

from one model to another. For example, cell r1c1 on sheet A can refer to cell r1c1 on sheet B for its value, but cell r1c1 cannot access a LOOKUP table or SUM range from sheet B.

Recalculation

Unlike many other spreadsheets, Multiplan offers a natural mode of recalculation. *Natural recalculation* begins by discerning the most fundamental cell in the sheet, that is, the cell on which the most other cells are based. This cell is evaluated first. Next, the program searches for the second most basic formula in the sheet and evaluates it. This process continues until the entire worksheet is recomputed. Multiplan also performs iterative calculations. The number of iterations can be determined by some predefined limit of change in a given cell.

Summary

Multiplan is close to being the ultimate spreadsheet program, although its large number of functions, formatting options, and commands can make it difficult to learn and use. However, the advantages of Multiplan far outweigh its minor flaws. If you are looking for a powerful electronic spreadsheet for PC*jr*, Multiplan is the program to choose.

Home Budget, *jr*

Application:	Personal finance
Price:	$45
System Requirements:	Disk drive
	DOS 2.1
	Cartridge BASIC
	(May require 64K and Display
	option to make full use of the
	program's capabilities)

Home Budget, *jr* is a new version of the popular IBM software product Home Budget. The program is intended for PC*jr* users who want to keep better track of their personal finances. The *jr* version of Home Budget is different from the IBM PC version primarily in that it can be used with a 40-column display. Home Budget on the IBM PC requires an 80-column display.

Home Budget, *jr* allows the user to set up as many as 48 accounts to track expenditures. As each account is defined, the user enters a monthly budget amount for that account. The program also has the ability to manage multiple special credit card accounts.

As the month goes by, the user enters each of his expenditures into Home Budget, *jr*. Each entry includes a description of the expense, a date, an account name, a dollar amount, and a special annotation. Home Budget automatically stores each expenditure under the proper account name.

The annotation can be used to subclassify expenses of certain types. For example, the annotation "TDE" could be used to mark all tax-deductible expenditures.

Home Budget, *jr* can also create a variety of financial reports, including an account listing and a report that shows all account totals. The program can also produce a detailed listing of every transaction made in a period.

One word of caution is needed. Keeping a set of books at home requires a great deal of discipline. The authors know several people who have jumped into home accounting with both feet forward only to be defeated by the amount of effort required to maintain good records. Computer consultants often warn businesses that a poor manual accounting system will not be made into a good system just by adding a computer. The same warning applies to home accounting. If you are already keeping good financial records, Home Budget, *jr* may be a big help. If not, you may want to start keeping manual records before you invest in a computer accounting system.

Conclusion

VisiCalc and Multiplan are both exceptionally flexible and powerful programs. VisiCalc is a legend. It has probably had greater effect on the microcomputer industry than any other software package. All other spreadsheets, including Multiplan, owe VisiCalc a tremendous debt. After five years, VisiCalc is still one of the best programs available for a microcomputer.

Multiplan should satisfy even the most demanding spreadsheeter. Its extensive capabilities allow large amounts of data to be linked

relationally. Although a small initial sacrifice of speed is encountered in developing Multiplan models, Multiplan provides highly sophisticated operations once the model is in place.

Home Budget, *jr* is a good complement to VisiCalc and Multiplan. You can use one of the electronic spreadsheets to build your personal financial plan and then use Home Budget, *jr* to track your actual expenditures. Remember, though—using a home accounting system like Home Budget, *jr* requires discipline.

Introducing Data Management

Data management is one of the most popular applications for computers of all sizes for several reasons. First, computers store data very efficiently. A single PC*jr* floppy disk can store 360,000 bytes of data, roughly equivalent to 180 pages of typewritten text. An IBM fixed disk (not available at this time for PC*jr*) can store ten million bytes of data—a file cabinet full—on a five-inch platter.

Computers also retrieve stored information quickly. Some programs can select a single piece of data from among thousands of records in a matter of seconds—a substantial improvement over the retrieval speeds of manual systems.

Most manual filing systems store each record under only one index. For example, a personnel file system might arrange the employee records by name, by employee number, or by length of service. Each arrangement may be helpful at one time or another. Unlike manual filing systems, computer files can have more than one index for each record. This means that a file can be rearranged at will to conform to the user's immediate need. After the user is finished, the file can be returned to the original or any other desired order. This feature makes computer file management vastly superior to manual filing.

Almost every business needs to store and retrieve vast amounts of information efficiently. Therefore, most business applications for computers involve data management. Accounting systems are really specialized data managers, as are calendar programs.

The problem of data overflow also occurs at home. Managing recipes, address lists, and inventories of personal property are all

file-oriented tasks. These needs have created tremendous demand for a wide variety of data management programs. IBM selected pfs:FILE and pfs:REPORT for PC*jr*.

The programs pfs:FILE and pfs:REPORT work as a team to store, retrieve, and present data. The FILE module stores and retrieves data, and the REPORT module formats the data for display and printing.

These two programs, introduced in 1981 by Software Publishing Corporation, became best sellers, despite heavy competition from programs like VisiDex™. They were originally designed to run on the Apple II computer.

Although pfs:FILE and pfs:REPORT are not super-sophisticated data base managers like dBase II™, FMS-80™, Condor™, and MDBS™, the two programs are more than adequate for many business and personal filing needs. Both come with excellent documentation. Even the beginning computer user will have no problem learning to use the pfs programs.

pfs:FILE

Application:	Data Management
Original Publisher:	Software Publishing Company
Price:	$140
System Requirements:	Disk drive
	DOS 2.1
	64K Memory and Display Option

The pfs:FILE can be compared to a card file filled with 3" x 5" index cards. The user designs input forms that allow data to be written onto these so-called cards. These easily designed forms can also be used to retrieve, modify, and print data. pfs:FILE can be used equally well at home or at work for simple data management chores.

The user retrieves information from the disk by selecting certain criteria that apply to the stored data. The criteria can be general or specific. In addition, "wild card" characters can be used to retrieve the data. For example, a search using the criterion "Doug" will result in a list of all records in which the first name was Doug. A search with the criterion "D....." will retrieve all records that included names beginning with D. Data can also be

retrieved with a "not" search. This kind of operation returns all the records that do not match a certain criterion.

Like most microcomputer file management programs, pfs:FILE has a limited storage capacity on 5 1/4-inch diskettes. If you have a great deal of data to store, you should consider acquiring an IBM PC with a fixed disk or another Winchester-type drive, instead of PC*jr*.

Both pfs:FILE and pfs:REPORT require an 80-column display. If you want a data manager that can be used with a 40-column display, you'll have to wait for some other program, like VisiDex, to be made available for PC*jr*.

pfs:REPORT

Application:	Report Generator
Original publisher:	Software Publishing Company
Price:	$125
System Requirements:	Disk drive
	DOS 2.1
	64K Memory and Display Option

The pfs:REPORT enables the user to produce reports using the data in files created by pfs:FILE. Like pfs:FILE, REPORT can be used both in the office and at home to simplify file management chores.

The program offers a number of options that can be used to create custom reports, including up to 16 columns of data. The user defines the contents and sequence of each column. Columns can be filled with data from a file or, by using the program's arithmetic features, from the results of calculations made on other columns. The math functions also allow reports to contain column statistics (such as averages and counts) and column subtotals and totals.

A report can include retrieval criteria that indicate which records should be printed. These criteria can be wild cards, "not" cases, and numeric ranges.

Once a report is created, the program automatically spaces the columns, centers the report on the page, and numbers the pages as it prints. Report forms can be stored on disk and reused later, thus

allowing reports to be defined and used repeatedly. Old reports can be modified as necessary.

The pfs:REPORT allows the data in a report to be sorted in ascending or descending order using the data in the first two columns as keys. For example, a personnel report might have the following data columns: employee name, address, telephone number, and years employed. This report can be sorted so that the records are in alphabetical order by employee name or arranged by address.

Conclusion

The pfs in the names of these two programs stands for *personal filing system*. These programs are not heavy-duty business data base managers. As personal tools, however, they are excellent. They are well designed, well documented, easy to use, and appropriate for many home data management applications.

Introducing Word Processing

What is a word processor? A *word processor* is much like a typewriter in that both machines have a keyboard and a printing device. But a word processor is much more than a typewriter. The magic of a word processor is the device that lies between the keyboard and the printer: the computer. The capabilities of word processing result from the ability of the computer to store, manipulate, display, and print the characters it receives from the keyboard. Whatever the operator enters into the word processor is captured and stored by the computer. Once stored, data can be retrieved for editing at any time.

The implications of this simple principle are remarkable. Because the text is saved for future use, the operator can enter text at full speed without regard for typing errors. Once the text is in the system, errors in spelling, punctuation, and usage can be edited out. A document stored on a word processor can be used again and again. For example, a form letter stored on a word processor can be printed any number of times by just a few keystrokes.

Another benefit of word processing lies in text revision. Before word processing was available, revising a document required

retyping it. The built-in editing commands in word-processing software make revision incredibly simple. These commands include the ability to delete and insert characters, lines, and blocks of text; to move text from one place to another in a document; to merge one document into another; to search for a particular string of characters in a document; and to justify and rejustify the text.

Most word processors offer special printing functions, such as boldface, underline, doublestrike, superscripts, and subscripts. These features add to the professional look of any document.

For writers, attorneys, and other professionals who produce long documents that require heavy revision, word processing is indispensable. Even for people who write smaller documents, like school papers and letters, word processors can be a big help.

IBM publishes two word-processing programs for PC*jr*: Easy-Writer and HomeWord. EasyWriter is a fairly simple word processor that can be used as either an advanced home word processor or a home system. HomeWord is a new word processor designed to be easy to learn and use. IBM also offers two text editors, Professional Editor and Personal Editor, for PC*jr*. These programs are intended for use in editing program code. Finally, the company offers a spelling dictionary, Word Proof.

HomeWord

Application:	Word processing
Original developer:	Sierra On-Line Systems™
Price:	$75
System Requirements:	Disk drive (DOS provided on disk) (May require 64K and Display Option to make full use of the program's capabilities)

HomeWord was developed by Sierra On-Line, a well-known publisher of computer games. In the past, Sierra has concentrated on developing products for the Apple II. In fact, HomeWord was first developed for that computer. In addition to developing the PC*jr* version of HomeWord, Sierra has announced plans to translate it for the Commodore 64 and Atari 1200.
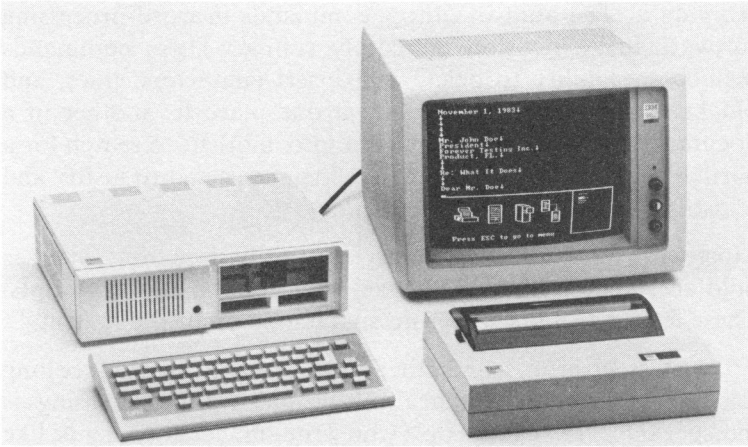
Pictured is a PC*jr with the IBM Color Display and the IBM Compact Printer. The picture on the screen is from HomeWord. (Photo courtesy of International Business Machines.)*

HomeWord is a simple yet remarkably flexible word-processing system. The program offers many features previously found only in advanced machines, such as the ability to move, insert, and delete blocks of text; to perform global and conditional search and replace; to format the text to be ragged left or left-right justified; to create (and save) variable margin settings and tab stops; to print boldfaced or underlined characters; and to inset headers and footers in the document. HomeWord can even insert special characters (graphics characters and special symbols) in the text file. The program is capable of merging two different documents.

HomeWord uses the IBM Compact Printer, the IBM Graphics Printer, or the NEC Spinwriter 3550. The program can also print to a variety of other printers attached to the serial or parallel ports.

All word processors for the PC*jr* are going to have to deal with the system's standard 40-column video display. Because a line of text in a letter or a paper is from 60 to 80 characters wide, a 40-character screen cannot display the document as it will look when printed. Although many home users are likely to buy the

enhanced PC*jr*, which has the 80-column display option, many other PC*jr*s will be used with home TVs in a 40-column mode.

One of the nicest features of Homeword is its "true page preview" option, which gets around the limitations of the 40-column display in a simple, straightforward manner. The lower-left corner of the HomeWord display shows a miniature version of the document as it will look when printed.

Another interesting innovation in HomeWord is the use of screen pictures, or icons, to represent the program's command options. In earlier word processors, editing might be started by typing "D" or "EDIT." In HomeWord the editing command is selected by pointing the cursor to a picture of a page with bright red Xs drawn in a few locations. To save a document or to recover a previously saved file, you point to a representation of a file cabinet. This use of pictures makes HomeWord very easy to learn.

HomeWord also has a customized keyboard overlay that indicates which keys serve which purpose in the program.

In hopes of making HomeWord attractive to the video-game generation, Sierra has designed HomeWord so that joysticks can be used to select from the different icons. If they are right, HomeWord might be just the tool to get your kids writing.

HomeWord is one of the most attractive word processors we've seen. It is easy to learn and use, yet offers most of the power of more costly word processors. HomeWord is an excellent basic word processor for your home.

EasyWriter Version 1.15

Application: Word Processor
Original publisher: Information Unlimited Software
Price: $175
System Requirements: Disk drive
                          DOS 2.1
                          64K Memory and Display Option
                          80-column Display

EasyWriter was the first word-processing program published for the IBM Personal Computer. Like other PC*jr* programs, Easy-Writer was first published for the Apple II computer. On the

Apple II, EasyWriter enjoyed a series of firsts: first word-processing program to use an 80-column video board (the Apple native mode is 40-character lines); first dynamically displayed text to be shown as it will be printed; and the first Apple program that permitted incremental spacing with suitable letter-quality printers.

The IBM versions of this program maintain the best of the Apple program's features and add others. Unfortunately, EasyWriter Version 1.0 suffered from a number of serious problems, such as a tendency to behave erratically. Version 1.1 has solved many of these problems, and owners of EasyWriter 1.0 can upgrade to 1.1 at no cost. Another version of the program, EasyWriter II, published by Information Unlimited Systems, differs significantly from Version 1.1.

John Draper, the author of the 1.7 version of FORTH for the Apple II, wrote EasyWriter, using the FORTH programming language. Although FORTH provides some speed advantages on an Apple II, the use of this language makes EasyWriter relatively inflexible in communicating with other programs (such as mail list managers or spelling dictionaries) created under PC DOS. Version 1.15 includes a translation utility that allows EasyWriter files to be converted into ASCII text files, but this utility is cumbersome and somewhat unreliable.

EasyWriter is user friendly. Like all PC*jr* software, EasyWriter comes with an excellent manual. Because the system is fully menu driven, novice users can gain proficiency quickly. Special help commands display the correct keystrokes for commands while the operator is editing.

In addition, the program offers a special "undelete" command that allows the recovery of most inadvertent deletions while in the editing mode. This feature is extremely valuable for users who occasionally make typing errors.

The program provides a wide variety of formatting options. For example, EasyWriter supports multiple titles and footnotes and allows titles to be placed anywhere on a page. This feature makes Easywriter a good program for writing papers and reports.

Text being edited by EasyWriter is displayed exactly as it will be printed, except for special printer commands, such as boldfacing or underscoring. This feature reduces the number of draft copies required to perfect a document's appearance. For this feature, Easywriter requires an 80-column display.

The program's menu-driven printer configuration program greatly aids the setup of the EasyWriter system for both IBM and non-IBM printers (parallel and serial). Extensive printing-format flexibility is available through menu-selected margin and page settings and placement of embedded commands for dynamically altering the appearance of the page.

Documents may be printed while in the editing mode and previewed on the video screen. The latter feature reduces the number of draft copies required to perfect the text.

EasyWriter permits the use of special printer characteristics (such as foreign language characters, reverse line feeds, and alternate character sets). Examples and directions are supplied in the manual for the special printer characters for both the IBM Graphics Printer and non-IBM supplied printers.

On the negative side, EasyWriter is slow in aligning text, moving to the beginning or end of a large document, and scooping text into the block movement buffer. Alignment (right justification) of the text still involves additional keystrokes if portions of the on-screen text have different margins and/or the document is less than 20 lines long.

In Version 1.0, the search and search/replace commands did not always function properly, but Version 1.1 corrects this problem. Searching for a specific phrase that occurs a number of times in the text, however, can still be troublesome.

Version 1.15 also improves EasyWriter's block move and block copy functions, but block size is still restricted. The amount of usable memory that the program can access is also increased. We recommend that you use Easywriter only with a 128K PC*jr*.

Personal Editor

Application:	Text Editor
Price:	$100.00
System Requirements:	Disk drive
	DOS 2.1
	(May require 64K and Display
	Option to make full use of the
	program's capabilities)

Personal Editor is a simple, easy-to-use screen editor for editing programs and short documents. Personal Editor is designed to be used primarily in writing programs. Although in a pinch it could be used as a word processor, this editor lacks many of the formatting features available in even simple word processors like HomeWord.

As a program editor, though, Personal Editor offers some attractive features. A Personal Editor line can be up to 255 characters long. In addition to the basic editing commands, the program offers special editing commands, such as block overlay and conversion of upper case to lower case and lower case to upper case. These commands are used infrequently for word processing, but they can be a real help in program editing.

Five screens of on-line help are provided to help the novice come up to speed quickly.

The most interesting feature of Personal Editor is its ability to redefine all the keys. For example, it is possible to define the key combination CTRL HOME so that it moves the cursor to the top of the current screen page, the top of the document, or the upper-left corner of the current page. In fact, the CRTL HOME keystroke combination can be defined to perform any function you desire, and CTRL A can perform any combination of functions you wish. The program also allows the creation of macros—predefined strings of commands that perform a combination of functions. For example, you can create a macro that automatically loads a program, defines new margins, reforms the text to fit those margins, prints, and saves the document.

Personal Editor also features an Undo key that reverses the effects of certain commands. For example, if you have inad-

vertently typed over some characters, you can restore them by issuing the Undo command.

Professional Editor

Application: Screen editor
Price: $130
System Requirements: Disk drive
                           DOS 2.1
                           64K and Display Option
                           80-column video display

Like Personal Editor, Professional Editor is designed primarily for use in writing applications. PE completely lacks the print-formatting options required by a word processor, so it cannot be thought of as a replacement for Homeword or Easywriter. But PE offers other features that make it a good editor for programmers.

The most important difference between Professional Editor and Personal Editor for PCjr users is that Professional Editor requires an 80- column video display, whereas Personal Editor can be used with a 40-column display (including a home TV). In addition, Professional Editor is $30 more expensive than Personal Editor. Other than these simple distinctions, we don't see enough difference between the programs to recommend one over the other.

If you are a programmer looking for a good editor, either Professional Editor or Personal Editor may do well for you. But if you need more than just a simple text editor, you should consider HomeWord. (PCjr's "advanced" word processor, EasyWriter, does not create standard text files, so it cannot be used for editing programs.)

Word Proof

Application: Spelling dictionary
Price: $60
System Requirements: Disk drive
                           DOS 2.1
                           (May require 64K and
                           Display Option to make
                           full use of the program's
                           capabilities)

As a group, spelling dictionaries are among the most innovative and useful programs available for microcomputers. A good dictionary performs the tedious job of checking every word in a document for correct spelling. With spelling dictionaries, virtually all spelling errors can be eliminated from your documents.

Word Proof is a spelling dictionary originally developed for the IBM Personal Computer. The program is fully compatible with the document files created by HomeWord. Because Easywriter 1.15 is written in FORTH, its text files cannot be easily used by other programs, including Word Proof. If you want to use Easywriter, you cannot use Word Proof. On the other hand, Word Proof should work with most word processors that may become available for PC*jr*.

Word Proof compares each word in a document against its predefined dictionary of over 125,000 words. Word Proof is a nonliteral editor. Although it can evaluate over 125,000 words, its dictionary contains less than half as many "pure" words. The other words are formed by combining prefixes and suffixes with existing words or by modifying words according to specific rules. Because of this limitation, on rare occasions the program will miss a word that is misspelled but meets the program's rules.

Like all spelling dictionaries, Word Proof cannot tell if a word is misused, only if it is misspelled. For example, mistyping the word "road" could create the word "toad." Because toad is an acceptable word, Word Proof will pass it by.

If you are a poor speller, Word Proof may be a lifesaver for you. At Que, we use spelling dictionaries to "proofread" our manuscripts, thus saving us hours of editing time. Word Proof can do the same for you.

Conclusion

Word processing may be the most important application for a home computer. Almost every member of a family can use a word processor, from children doing school papers to adults working at home. If you are a writer or other communications professional, a home word processor may be essential.

If most of your word processing will be light and casual, HomeWord may be ideal for you. The program is simple enough even for young children to learn, but it offers enough power to be used for many sophisticated applications.

If you need a more powerful editor, especially for creating program code, you may want to consider Professional Editor or Personal Editor. Don't expect either of these programs to do the work of a word processor, however. They lack the print-formatting features required in even the simplest word processor.

If you want a word processor that is more advanced than HomeWord, EasyWriter may be the best choice, especially if you want to get your PC*jr* right away. On the other hand, other good word processors, including WordStar, Multimate, WordPerfect, and PeachText™ will soon be available for PC*jr*; all of these are preferable to Easywriter 1.15.

Communications

IBM offers two useful programs that allow PC*jr* to communicate with other computers across telephone lines: Dow Jones Reporter and Personal Communications Manager.

Dow Jones Reporter

Application: Telecommunications
Original publisher: Dow Jones and Co.
Price: $100
System Requirements: Disk drive
                               DOS 2.1
                               Cartridge BASIC
                               Modem
                               (May require 64K and Display
                               Option to make full use of the
                               program's capabilities)

The Dow Jones Reporter program has been available for several years on a variety of popular home and business computers, including the IBM PC and the Apple II. The Dow Jones program makes it possible to tie directly into the Dow Jones News and Quotes service to obtain instant financial information.

To use Dow Jones on your PC*jr,* you need a modem. The Internal Modem will do fine. It is easy to connect to the Dow Jones Service. Once you are on line, the Dow Jones software makes it possible to scan through financial news and quotes and to download information and store it on your floppy diskette for future use.

The Reporter won't let you buy or sell securities. For this activity you must have a "seat" on one of the stock exchanges. Dow Jones Reporter may keep you better informed, but it won't lower or eliminate your brokerage commissions.

If you are a serious investor, Dow Jones Reporter may help you keep better track of your investments. Even though you may not be a heavy investor, but simply enjoy following the financial markets, Dow Jones Reporter may be fun for you. Otherwise, Dow Jones is probably one program you can skip.

Personal Communications Manager

Application:	Electronic Mail
Price:	$100
System Requirements:	Disk drive (DOS included with program)
	Modem
	(May require 64K and Display Option to make full use of the program's capabilities)

Personal Communications Manager (PCM) is a program developed by IBM especially for PC*jr.* Like Dow Jones Reporter, Personal Communications Manager allows PC*jr* to communicate over the telephone. Unlike DJR, which is a specialized package, PCM is a general purpose communications tool.

PCM is a sophisticated communications management and electronic mail program. With it, PC*jr* can be an electronic mail system or a terminal for a larger computer.

The program can maintain an "address book" of up to 40 names. PCM really does not maintain addresses, however, but telephone numbers. When you instruct PCM to send a message to a certain person, the program automatically looks up the number in the address book and sends the message. You can instruct PCM to

send a message at a particular time or to send the same message to many individuals.

PCM is also capable of receiving messages sent from other computers over the telephone lines. Once you set up PC*jr* and PCM, you can leave the computer alone. Any incoming messages will be automatically received and stored for your review at any time.

PCM can also be used to connect PC*jr* to another computer for direct communications. The computer you are talking to could be a larger computer, like the one at your office. You can use PC*jr* to obtain information from that computer for use in a VisiCalc projection or HomeWord memo. Or you can communicate with one of the popular on-line services, like the Source or Compuserve, which provide news, airline schedules, and other on-line services. You can even use PCM to connect two PC*jr*s so that information can be sent back and forth between the machines.

PCM provides the first hints of what may be one of the most important uses for home computers—communications. If you plan to use PC*jr* as a home office computer or if you have special needs for communication, PCM may be valuable to you. Even if you are not sure that telecommunications is important to you, you may want to experiment with PCM.

Conclusion

PC*jr* offers one of the largest and most powerful libraries of personal management software available for any home computer. In fact, PC*jr* offers some programs that were previously only available on expensive desktop computers. If you are in the market for a home computer to be used primarily as a home accounting system or home word proccesor, PC*jr* would be an excellent choice.
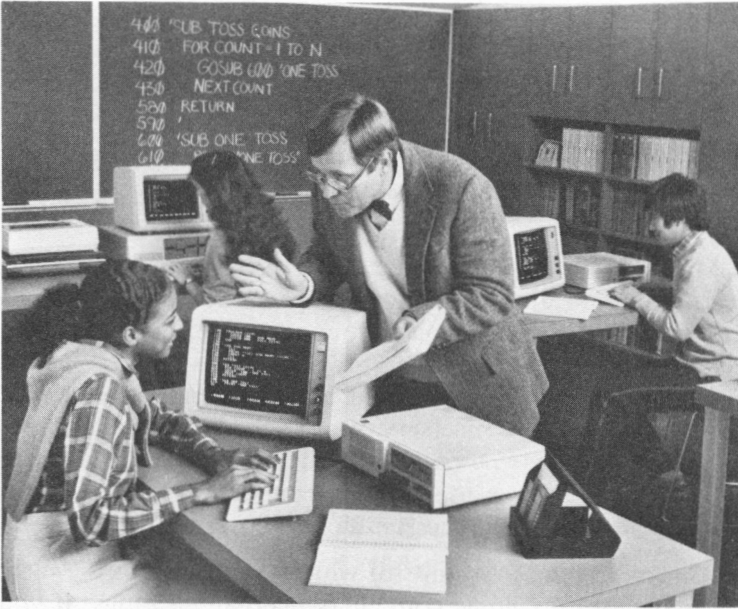
Two uses for PCjr *in education are computer literacy and computer programming. Pictured is a group of students learning BASIC. Two students (front and left) are using enhanced PCjrs and Cartridge BASIC. The student in the background is using a PC. (Photo courtesy of International Business Machines Corporation.)*

7

PC*jr* for Education

Educational Software

Microcomputers and education are a combination that is here to stay. PC*jr*'s price, features (primarily sound and color graphics), and supporting software show that IBM has geared this computer to both home and classroom. PC*jr*'s software ranges from programs that tutor three-year-olds to those that help students prepare for college entrance examinations. Adult continuing education courses are also available for the IBM PC family.

Microcomputer-aided home education is becoming increasingly popular and is often the justification for the purchase of a computer. The machines can make learning fun, for both children and adults, by catching their attention and painlessly sharpening their skills. In school, microcomputers can supplement teacher instruction. Students who have trouble keeping up with certain subjects, gifted pupils who want to accelerate their learning, and students who are about to enter the job market can all benefit from using computers. Each semester the subject of computer literacy—how to use the machines—is taught in more and more schools.

Classroom Computers

In schools, computers like the PC*jr* are used in four principal areas: computer literacy, computer-assisted instruction (CAI), vocational training, and computer programming. Computers can perform at home almost in the same way as those used in schools.

Computer literacy deals with what a computer can and cannot do—that is, the very basics about computers, including their construction and use. Because computers now have such a tremendous impact on how we work and live, computer literacy is becoming increasingly vital. A proposed bill in the United States Congress calls for all school systems in the United States to offer a course on computer literacy by 1985. Students must acquire basic computer skills and familiarize themselves with the limits of computers so that they are not intimidated by them. Courses in computer literacy try to dispel misconceptions about the machines and to address morality in computer use (including illegal accessing of a large computer through a telephone connection, illegal copying of programs, and tracking).

Computer-assisted instruction (CAI) uses computers to supplement the noncomputer subjects taught in schools. Here, the computer becomes a teacher's aide. By disguising lessons and drills as competitive games, microcomputers make learning more fun. Equipped with the proper programs, the computer becomes a captive and patient teacher that can devote endless attention to the student and never become annoyed or cross. Students are able to move at their own individual paces; they can review difficult subjects or explore new material. Computers cannot and will not replace teachers. However, the machines can be valuable tutoring aids.

Vocational training is another major educational area in which microcomputers are used. Principally, office-automation skills, including word processing and data entry, as well as computer programming, are taught in vocational courses. Vocational training can also include business courses, some of which use microcomputers to teach accounting and spreadsheeting.

Fundamental office skills, such as word processing and data entry, are easily taught on microcomputers. However, these

courses cover only the very basics. Usually, students will need additional training on the specific word processors or data entry machines used in a particular business. However, graduates of these vocational courses need less training than applicants who must be trained "from scratch," and these graduates are therefore in higher demand.

Computer programming can be a vocational education course or may be taught in other departments in the school. Colleges usually have a separate computer science department. The mathematics or science department in primary and secondary schools may offer programming courses as well. Some school districts offer them in several departments. Don't confuse computer literacy with computer programming. Computer literacy courses may teach a little computer programming, but the primary goal of these courses is to familiarize people with the machines.

The most common languages taught in schools are BASIC, COBOL, FORTRAN, Logo, and Pascal. BASIC is the most popular for microcomputers and is easily learned by beginning programmers. Logo is also becoming popular. COBOL, the classic language for business, is used mostly with large computers. FORTRAN has predominantly scientific and engineering applications. Pascal, also a beginner's language, is more difficult to learn than BASIC or Logo.

Where PCjr Fits in the Classroom

PC*jr* is an ideal machine for computer literacy purposes. The entry PC*jr* can be used in a school for teaching the subject. However, most school corporations and their students will find that storing and recalling programs from cassette tape is awkward. The enhanced version of PC*jr* is a better choice for these tasks.

PC*jr* is good for computer-assisted instruction (CAI). However, most CAI programs demand a large amount of computer resources, which makes the entry PC*jr* unsuitable. The enhanced PC*jr* may not be sufficient for all CAI programs either. PC*jr*'s

major limitation is its single disk drive, which may not be enough to store all the information that some CAI programs need. However, enhanced PC*jr* has enough disk storage for most CAI programs.

The flip side of the CAI coin is software. Computer literacy courses use some of the same common, off-the-shelf commercial packages in most businesses and homes for training students how to use computers in business problem solving. The rest of computer literacy course work is "show-and-tell," involving written material and a small amount of computer programming. This part of computer literacy and all of computer programming use the available programming languages for the computer.

CAI needs special educational software, unlike computer literacy and computer programming courses. The software is the key to CAI. Without the right software, a computer cannot be used for computer-assisted instruction.

CAI programs excel in their treatment of the subject matter. To make the computer as easy to use as any other audio-video machine (like a movie, overhead projector, or tape recorder), CAI programs must be very sophisticated: simple to use, visually captivating, very tolerant of wrong answers, and difficult if not impossible to "crash" (halt). CAI's purpose is to make learning attractive. To weave program friendliness and fun into the subject matter is very difficult.

Since CAI programs are visually simulating, they are geared to the particular computer system on which the program will run. Therefore, most programs run only on a few machines.

For these reasons, there is less CAI software than business or home management software. Most CAI software has been written for the Apple II, still the most popular computer in school districts. The major supplier of educational software in the United States is the Minnesota Education Computing Consortium (MECC). Nearly all of MECC's software runs on the Apple computer. However, MECC is converting most of their programs for Commodore 64 and the IBM Personal Computer family, including PC*jr*.

Other companies are converting CAI programs that run on the Apple or Commodore computer to *PCjr*. The programs by the Learning Company, discussed later in this chapter, were adapted from Apple and Commodore for *PCjr*.

The SRA software for the PC family will also work on *PCjr*. SRA, an IBM subsidiary and another leader in the educational field, is working on more programs for *PCjr* that will be released next year.

The bottom line to the use of *PCjr* for CAI is this: Apple has more CAI software than *PCjr* today, but *PCjr* will rapidly catch up. *PCjr* is capable of running most CAI programs.

PCjr can be used for vocational training purposes but is not suitable for courses that need to train students on the identical equipment to be used in a business environment. These courses use word processors and data processing machines that *PCjr* cannot replace.

Vocational courses that do not require particular office machines can use *PCjr* for some training. Word processing, data entry, spreadsheeting, or accounting concepts can be taught on *PCjr*.

For teaching programming, *PCjr*'s single disk drive limits the number of languages that can be taught. Today, *PCjr* can run only the BASIC, Logo, and Macro Assembler languages. *PCjr*'s best use in computer programming will be to teach BASIC or Logo.

Home Educational Uses

PCjr's home education applications focus on computer literacy, CAI, and computer programming, just as schools do. Many families are purchasing computers for their homes to give their children a competitive educational edge. However, the educational uses are not limited to children. Adults can also benefit; *PCjr* has several adult continuing education courses. In many homes computers have replaced televisions as centers of learning and entertainment.

The Educational Software

The major educational programs for PC*jr* can be classified according to the age groups for which they are intended: preschool, elementary, and junior high school. Three additional categories for CAI or instructional material are high school, college, and adult continuing education. Currently, IBM does not offer CAI software in the last three areas. Your local school classifications may differ slightly, but these are the standard divisions. Children in different age groups, as well as adults, may use software from another category for tutoring purposes or advanced studies.

Remember that PC*jr* runs most PC and PC XT programs. There are many excellent non-IBM educational programs, too. For more information, you might consult product directories like Que's *Expansion and Software Guide for the IBM PC*.

Most of the programs presented in this chapter were originally written in BASIC. All require the enhanced version of PC*jr* because the programs are distributed on diskette. Cartridge BASIC is also necessary.

Preschool/Elementary

Juggles' Butterfly™ (Ages 3-6)

Juggles' Butterfly™ is the first of four programs written by the Learning Company of California.

Juggles is a colorful clown who helps the very young learn the concept of three-dimensional space and some letters in the alphabet. Three games introduce a youngster to a computer even before that child can read. The games make extensive use of color and sound to help keep the child's attention. Because a child of this age does not read well, if at all, most directions are provided through music and color.

Either an overlay or blue strips are placed on PC*jr*'s keyboard, dividing it into four areas. The games on the screen correspond to the quadrants on the keyboard. When the child presses the keys in

a quadrant, pictures appear. The games teach the concepts of above, below, left, and right; and also introduce lines and circles. Using these concepts, the program and PC*jr* can teach the letters "p", "d", "b", and "q"—the most difficult to learn because of their similar shapes.

Children using PC*jr* sharpen three skills: reading and math readiness, spatial awareness, and hand-eye coordination. The last is stimulated as the child's eyes move from the screen to the keyboard, then back to the screen. This training is similar to that of the child learning to refocus the eyes rapidly between the blackboard and desk top.

Juggles' Butterfly, along with most of the educational software in this group, comes on a PC DOS diskette, which is preinstalled and may be used to start PC*jr* without any additional preparation. However, PC*jr* must have Cartridge BASIC to run Juggles' Butterfly, as well as most of the other educational games.

Bumble Games™ (Ages 4-10)

Bumble (from the planet Furrin) makes its first appearance in this Learning Company game. Bumble Games uses much of the style of Juggles' Butterfly to teach concepts. Graphics and sound are extensively used to keep the child's attention. The six games are arranged in ascending order, according to degree of difficulty.

The games' concepts, "less than" and "greater than," make use of charts, coordinate systems, and two-dimensional graphs. These tools also help build concepts needed in computer plotting.

Many of the games are based on the X, Y coordinate system. In Bumble Games, numbers label one dimension and letters, the second. Many of the games revolve around the child guessing the correct number or square the computer has picked. Because the player gives the X (lettered) and Y (numbered) answers separately, the two axes can be focused on individually. The program tells the child if the correct answer is farther up, down, left, or right than the child's conjecture. Greater-than and less-than concepts are therefore learned.

Elementary/Junior High

Bumble Plot™ (Ages 8-13)

Learning Company's Bumble makes an encore appearance in this game, which builds on the skills learned in Bumble Games. Bumble Plot introduces negative numbers in the two-dimensional coordinate system. Five progressively harder games help children learn math, graph, and charting skills.

The first game challenges the child to guess the number the computer has picked. As in Bumble Games, the computer's clues tell the child if its number is less than or greater than the child's conjecture. The first game uses a straight, one-dimensional line. The second game progresses into a 7 x 7 grid that uses positive and negative numbers. The third game uses a 10 x 10 grid. The fourth involves moving five blockades to catch a crook before the crook escapes from the grid. A timer, based on response time and moves, limits the length of the game. (In a practice game the crook proved to be smarter than this author; time ran out before the crook was captured!)

The final game is connect-the-dots. The child draws pictures on the screen by giving X, Y coordinates to the computer. In one version the child can select a figure from a list of several, each with more than four dots to connect. The computer flashes a spot on the grid where the dot should be placed. If the child gives the wrong X, Y coordinate, the computer provides a hint and lets the child try again. The other version of the game lets the child draw in free-form style, using the X, Y coordinates. In both versions the computer draws the line that connects the dots on the grid.

Monster Math (Ages 8-14)

Monster Math is to arithmetic what Hangman is to spelling. The difference is that in Monster Math the child tries to solve problems to make the menacing monster disappear. The child selects from four different kinds of math drills: addition, subtraction, multiplication, and division. A fifth set of drills features all four arithmetic operations. Six different levels of difficulty (grades 4 through 9) are available.

The child has sixty seconds to make the monster disappear. Arithmetic problems flash on the screen in arcade fashion. For each correct answer, points are awarded and bits of the monster vanish. To build excitement, the countdown clock on the screen shows the child how much time is left. At the end of the round, the timer shows the score for the round and the child's best score so far. As with the other educational games, color and sound are extensively used.

Because Monster Math is a competitive arcade-like game, children may try to guess the answer for the next problem. The program randomly selects the number in the problem so children can't guess the next answer.

Monster Math is the electronic equivalent of flash cards, but far more exciting.

Arithmetic Games Set 1 (Ages 10-14)

SRA, the educational subsidiary of IBM, is the author of Arithmetic Games Sets 1 and 2. They were introduced with the original PC. Both "drill" children's arithmetic skills in a pleasant and challenging way. Arithmetic Games 1 has two games, Beano and Rockets.

Beano is computerized Bingo with one unique twist: the computer rolls a set of dice that are operated on to make a number for a card. The child competes against the computer or a friend. Three different levels of difficulty are available from which to choose.

The Beano card has 25 squares. The center box, like a Bingo card, is "free." The easier versions of Beano have several other free boxes as well. Depending on the level of difficulty, the computer rolls two or three dice. The first level uses two dice numbered from 1 to 9, and the Beano card uses numbers 1 to 18. At the middle level, the computer rolls three dice numbered from 1 to 6, and the card uses the numbers 1 to 25. The hardest level uses dice numbered from 1 to 9, and a card uses numbers up to 50. If a player chooses to play against the computer, it competes at the third level.

When the dice are rolled, the child or computer performs arithmetic operations on the two or three numbers. The numbers

may be added, subtracted, multiplied, divided, or operated on in any combination of these. In the three dice games, parentheses can be used to group the numbers for the operation. The result must be a positive integer.

For example, if the computer rolls the numbers 2, 4, and 5, the following seventeen different operations are possible:

```
 2  +  4  +  5  =  11
 2  +  4  -  5  =   1
 2  +  5  -  4  =   3
 4  +  5  -  2  =   7
 2  x  4  x  5  =  40
 2  x  4  -  5  =   3
 2  x  4  +  5  =  13
 2  x  5  -  4  =   6
 2  x  5  +  4  =  14
 2  x (4  +  5) =  18
 4  x  5  -  2  =  18
 4  x (5  -  2) =  12
 4  x (5  +  2) =  28
(4  x  5) +  2  =  22
(4  x  5) /  2  =  10
(4  /  2) +  5  =   7
(4  /  2) x  5  =  10
```

The player types in the left side of the formula, then the answer. If both are correct, a bean is placed over the square on the card that has the answer to the formula.

Beano encourages youngsters to examine how numbers and arithmetic operations can be grouped in different ways. The numbers are split and recombined in ways that cannot be duplicated by memorizing multiplication tables.

The competitive aspect makes the game even more exciting as each player takes a turn at putting a bean on the card. When only one or two squares are left, it can be maddening to try to form the two or three numbers into a formula that matches the open squares. Missing the right combinations is even more frustrating. Adults will find playing against the computer challenging.

The game of Rockets pits two players against each other. (The computer may be one of the players.) Each competitor has a rocket ship that can move up, down, left, or right, on a 15 x 15 grid. Just as in Beano, two or three dice are rolled, and the same operations are performed on the two or three numbers. However, the answer is used to move the rocket ship a corresponding number of squares on the grid. After a rocket ship moves, it fires a missile in each of the four directions. If the opponent's rocket is horizontally or vertically aligned with its adversary, the opponent's rocket is blown to electric oblivion. Rockets combines a little chess-like strategy and math prowess with blind luck. Calculating the numbers to move involves the same mental exercise as in Beano. Playing against the computer in both games can be frustrating because it never makes a wrong calculation. The computer does not always win, however, since the dice are randomly thrown and the possible combinations are not always winning ones.

Beano and Rockets make learning fun; both use color graphics and sound to simulate play, but neither is as exciting as a traditional "shoot-em-up" arcade game.

Arithmetic Games Set 2 (Ages 10-14)

The second set of two games from SRA contains Number Chase and Discovery Machine. These build on the skills learned in Arithmetic Games 1.

Number Chase has four levels of difficulty, using two- to five-digit numbers. When the child plays the computer, four-digit numbers are used.

The game is played like Mastermind, but instead of guessing the colored squares, the child types the two-to five- digit number. The computer displays which digits are correct and which are in the proper order. Unlike Mastermind, the computer gives a clue as to what numbers remain. This hint is the sum or product of numbers that were not guessed. Other clues are available after the third round, if the child sacrifices a turn. The game lasts for a maximum of fifteen turns. If the number has not been deduced after the fifteenth round, the computer reveals the answer.

Discovery Machine is like Number Chase. The object of Discovery Machine is to figure out what mathematical operation the computer is performing in the magic box. The computer picks a number and throws it into the box. A number pops out. Now the child must enter a number into the box and then enter a guess for the number that will come out.

For instance, the computer starts by throwing a 2 into the box, and an 8 comes out. The computer may have done any one of the following:

- Added 6 to the number
- Multiplied the number by 4
- Subtracted the number from 10
- Added 14 to the number and divided by 2

The sleuthing required to discover the operation in the box is difficult but fun. After the child has given three sets of numbers and correct answers in a row, the computer proclaims that the child has broken the code. Putting the right numbers into the box to deduce the code is the key. To prevent the child from becoming frustrated, the computer displays the contents of the magic box after the tenth consecutive incorrect answer.

Adventures in Math (Ages 8-14)

In this Adventure game, one or two children move through a mysterious castle. To open doors and retrieve treasure, the child must solve an arithmetic problem that can involve addition, subtraction, multiplication, division, or a combination of these operations. There are six levels of difficulty and three sizes (small, medium, and large) of castles. Problems are randomly selected so that arithmetic tables can't be used to solve the problems.

To equalize play between competitors with different degrees of skills, each player can select an appropriate level. The computer keeps track of the players' progress and automatically adjusts problem difficulty as the game continues. Play between children with uneven skill levels is enlivened; neither player can "run away" with the game. Like Monster Math, the computer keeps track of the score and records the highest score, along with the

player's name, on the disk. Color and sound combine to make this version of Adventure an exciting and fun way to build math skills.

Other Educational Programs

IBM does not have a monopoly on educational software for PC*jr*. Scores of other companies have produced programs (for pre-schoolers through adults) that run on the entire PC family.

You may have noted that most of the CAI programs involve math. This is a challenging subject for youngsters. However, there are programs on high school and college levels that offer tutorials or games for geometry, trigonometry, and even calculus.

Many third-party software companies offer a variety of games and tutorials. A sampling of educational programs includes those covering English words, spelling, sentence structure, letter writing, and prose and poetry styles. Geography games teach the names and locations of states, capitals, and European countries. One company offers a chemistry "poker game" for high schoolers; they are dealt basic elements, and they score points by combining the elements into compounds. Speed-reading programs are available for children and adults. A course on the Mormon religion is also published.

In addition to all of these, several courses are available for learning how to program in BASIC. IBM also provides a tutorial with the enhanced version of PC*jr* and sells a BASIC language tutorial for PC*jr*.

Teachers are not ignored by educational software companies. Several programs are offered for keeping track of student scores and grading test papers.

Most educational software that runs on the PC or PC XT will run on PC*jr*. The "knockout" that will prevent many programs written for PC and PC XT from running on PC*jr* is the need for either two disk drives or the intimate (and unnecessary) use of the ROMs inside the bigger machines. However, most other programs that work on the PC should work on PC*jr*. Cartridge BASIC will be required by most programs.

Looking Back

IBM offers a variety of educational programs for PC*jr*. Most educational software is aimed at preschool through junior high school students, but children (and adults) outside these age groups can also play the games. One author of this book found most of them enjoyable; in some cases, the computer presented problems the author almost missed solving.

IBM does not offer adult education software, but many third-party companies currently offer programs that run on the enhanced PC*jr*, and more will be available as time progresses. Speed reading, computer usage, and programming are examples of such programs.

Apple currently dominates the educational marketplace. PC*jr*, whose price, color graphics, and sound make it an ideal educational tool, will be joining Apple at the top.

8

Entertainment Software

A public service announcement blares, "Parents, do you know where your children are?" The father and mother look over their glasses at their teenage daughter and her boyfriend in the den. They don't mind the two teenagers playing with PC*jr* late on weekends.

"At least I know what games they're not playing," the father mutters.

In an executive's office in a high-rise, the secretary has been instructed to hold all but emergency calls. A disk is pulled out of a desk drawer and inserted into the computer; the executive begins struggling to survive among the treacherous traps and monsters in the caves . . . .

"Daddy, when can I play with the computer?"

"Daddy's doing some important business work. You'll have to wait."

"Then why are there playing cards on the screen, Daddy? It says you won $50."

A mother shouts up the stairs, "Johnny, turn the computer off and do your homework!"

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"All right, Mom," the boy replies. Johnny opens his school books. He'll finish his homework in an hour. He'll outfox the computer in another round of Battleship and Elusion later.

"Gee, Marge, you look terrible this morning. What happened?" Glenda asks.

"I kept dying when I got to the cliff and the rattlesnake bit me," Marge replies.

"What!" The two-octave rise in Glenda's voice betrays her astonishment. "Rattlesnakes in this area?" she wonders.

These are true-to-life stories. These people suffer variants of a dread disease striking thousands of adults and children alike—game-itis, also known as arcade game-itis or computer game-itis. The symptoms of this disease are sleepless nights, blurred vision, high anxiety, push-button thumb, and joystick wrist. The victims may sometimes be found in a catatonic state in front of a TV or display screen; at other times they may twitch nervously and shout periodically or mumble loudly. There is no known cure for this epidemic.

This disease was first observed almost thirty years ago. It began innocently enough when some programmer taught a computer how to play tic-tac-toe with punch cards. Later, the disease struck a group of programmers using a DEC PDP-7™ computer. A mysterious computer program (it may have been called Space Battle) showed two competing space ships on an oscilloscope display. The two ships attempted to blow each other into the nether world while avoiding a star in the center of the screen. If either ship got too close to the star, it was pulled by the gravitational forces of the star and crashed. These games were the forerunners of the text and arcade games played on computers today.

One of the alluring features of a computer is its ability to converse with a person, display color, play sound, and "act intelligently." The same capabilities that make a computer a perfect tool for business and education also make a computer a wonderful game player. Not only can computers display the game board and referee the game, but they can also act as one of the players.

Pictured are two children playing Mine Shaft, one of the four cartridge games for PCjr. The black second button on the back of the IBM Joysticks is barely visible on each joystick. (Photo courtesy of International Business Machines Corporation.)

The software industry has not ignored the fact that games are natural programs for computers. Entertainment is one of the largest areas of computer software.

Officially, Microsoft BASIC is the most popular computer program in the world; it runs on more computers than any other program. (Unofficially, however, this author believes the most popular computer program is Star Trek.)

IBM has not ignored the entertainment market. When the Personal Computer was announced, several games were also announced. New versions of these games, along with several new games, came out with PCjr. Between the time of the original PC and the PCjr announcements, several other games have been marketed by IBM.

Are Computers Better for Games?

You may wonder which are the best games: home video, commercial arcade, or computer. Each is best in certain areas.

The best video graphics for games are on commercial video games in the arcades. The video monitor's resolution is superior and its color graphics almost impossible to beat. The game machine usually has one or more microprocessors inside. The entire machine, designed for playing one particular game, is therefore a kind of dedicated computer. For these reasons, commercial arcade games are best for playing the "shoot-em-up" games. However, the price of a quarter to one dollar per game drains a child's allowance faster than the a Good Humor ice cream truck.

Some of the most popular home arcade games are Atari, Coleco, and Mattel. Coleco gives the best video graphics. The next three, in order of graphics superiority, are the Atari 5200 system, the Mattel Intellivision, and Atari 2600. These game machines are dedicated to executing their cartridge software, and the game controls are responsive and easy to use. However, because the games use a television for the video display, they do not have the resolution of the arcade games. Nor do the home arcades have sufficient "intelligence" to play very sophisticated games.

Computers, on the other hand, are general-purpose machines. They can do your accounting, figure your budget, and educate you. Until the Apple computer appeared on the market, few computer games were as exciting as arcade or home video games. The displays were black and white, and the keyboard was the only way to control the game. Typing on a keyboard certainly does not give you the "arcade feeling." Still, some excellent prose games were developed for computers. These games were played by typing words or phrases into the computer; the computer's response was also in words.

Gradually, text games became more visually oriented. Star Trek was one of the first computer games that put information in selected parts of the video screen, thus making the screen and the game a little more exciting.

Then Apple, the first computer to have color graphics and sound, was introduced. Soon Apple began marketing graphics-oriented computer games. Compared to an Atari 2600 home game, the Apple's graphics were better. Apple also used game paddles; they were not as good as joysticks, but they were usable. The Apple was not a bad game player, but the Atari home arcade still had a better selection of games.

As the microcomputer brought more computing power into people's hands, the game software market grew. Computer games became more arcade-like, more sophisticated. When Atari was introduced, many consumers were in awe of its graphics. True arcade-game graphics had finally come to computers.

Today a few arcade-style games are actually better on computers than on their commercial counterparts because of the computer's greater "intelligence." If you use a television, the quality of the display decreases somewhat; an RGB monitor usually gives the best picture. Computers with joysticks have an edge because they are easier to use than typing on a keyboard.

PC*jr* has what it takes to be a good game-playing machine. PC*jr*'s color graphics and sound are good enough to give the arcade feeling. However, PC*jr* cannot run all arcade games as well as the commercial versions. PC*jr* has three graphics modes: 160 by 100 in 16 colors, 320 by 200 in four colors, and 640 by 200 in black and white. Because game programs use color, the 640 by 200 mode is not attractive; and at 160 by 100, PC*jr* cannot match arcade games. At 320 by 200 in only four colors, PC*jr* does come close. Due to the lesser graphics capabilities, some small features of a game may be sacrificed, but the PC*jr* version will satisfy most arcade game aficionados.

Prose Games

Early computers used punch cards and teleprinters (combination printer/keyboard) for input and output. As a result, most computer games minimized the amount of interaction between the player and the computer to lessen transmission time and the use of printed paper. Another drawback was that computers did not have much RAM (back then it was magnetic core memory) for games. Therefore, the games were not very sophisticated.

Prose or text games were developed next. The computer led the player through a game, using as little typing as possible. Originally, the game was loaded on paper tape, which was a slow method. As disk drives became more popular, the games depended more on disk storage than on RAM memory. Adventure was constructed and played within these constrictions.

The thrill of the arcade game does exist in a prose game. Although graphics are not displayed on the screen, the descriptive text paints a picture, and the player's mind adds the realism.

Adventure

The most advanced computer game of the early seventies was Adventure, originally developed on a DEC minicomputer. Adventure by Microsoft, the microcomputer version of the game for the PC and PC*jr*, does not sacrifice any of the original features.

Following are the opening two scenes from Adventure. The computer does not display the picture, but the prose paints it vividly.

"You are standing at the side of a road before a small building. Around you is a forest. A small stream flows out of the building and down a gully."

"You are inside a building, a well house for a large spring.

"There are some keys on the ground here.

"There is a shiny brass lamp nearby.

"There is food here.

"There is a bottle of water here."

The object of the game is to play a perfect game by scoring 350 points. How the adventurer accomplishes this task is the secret of Adventure.

The adventurers type their moves into the computer. A move can be up, down, east, west, north, south, northeast, northwest, southeast, or southwest. These moves can be abbreviated to one or two letters. Other instructions are more complex. Because the

instructions are limited to one or two words, learning what instructions to give and when to give them is the hardest part of Adventure.

Sometimes the order in which the events are played spells the difference between success and failure. In the worst case, the adventurer dies and must be resurrected by the computer. However, the progress of the game may be saved, and the adventurer can return to the game later.

One warning comes with this game: it is frustrating and addictive. Discovering the right words to unlock treasure and maneuver through the cave is difficult. You can spend hours finding the right phrases at some points in the game. Digging into the computer's prose and looking for the clues that lead to treasure taxes your imagination. Hapless adventurers can stumble into an almost endless maze and never return. However, the true fun of Adventure is the reward of seeing your score increase game after game.

Adventure is not a game for youngsters. Although ten-year-olds can play the game, it takes the logic and patience of a mature person to play this game successfully.

Adventure is almost a mystical rite of passage for computerists. You cannot be accepted into the guild of accomplished computer programmers, operators, and users until you have conquered Adventure. Because it is "immoral" for a member of the guild to tell a novice how to "crack" the game, you will need to play the game yourself.

Adventure is almost as classical a game as Monopoly. The fun of Adventure lasts until you score the perfect game, which usually happens hundreds of games after the first time you play. To those who attempt to gain this rite of computerhood: may the dwarf not haunt your passage and may your batteries last forever.

Adventure in Serenia

Adventure in Serenia is a second-generation Adventure game. You have been magically transported to the land of Serenia. The evil Wizard Harlin has abducted the beautiful Princess Priscilla and taken her to his castle beyond the mountains in the north.

You must traverse the treacherous terrain, solving clues and avoiding hazards along the way.

The difference between Serenia and Adventure is that in Serenia the computer displays the scenes—mountains, deserts, the chasm—as well as the monsters and other hazards. As you move, the scenes change. Unlike arcade games, the scenes are static. Monsters and objects do not charge or attack on the screen. A four-line area beneath the picture describes the action or provides further information; you type your moves in this area.

Like Adventure, the moves are one or two words long. Most positional moves can be abbreviated to one or two letters. This game, too, can be frustrating. Figuring what the right move is and how to state the right move can take hours. Adventure in Serenia is truly a delightful game. The on-screen scenes captivate both youngsters and adults. However, the game is not for the tots or young children. Junior high school age and up comprise the audience for this game.

Adventure in Serenia does not have the classic prose of Adventure. Serenia challenges the player, but the game does not paint the vivid word pictures of the classic Adventure. Adventure in Serenia is an excellent second-generation adventure game that provides many hours of entertainment. But somehow, in some way, this adventure does not capture the imagination and have the sentimental following of the original Adventure. Maybe attempting to compare this game with the classic Adventure and finding that Serenia falls short is the reason.

Table and Board Games

This category of games includes newer versions of two sets of games for the PC family. Casino Games is your chance to gamble with "funny" (nonreal) money in high-stakes action. Strategy Games consists of four different strategy games.

Both sets of games have first-generation versions, V1.00, but PC*jr* cannot use these versions. You will need Cartridge BASIC and the new V1.05 versions for PC*jr*.

Casino Games

"Welcome to the PC Casino. I see you have three friends with you. I'm glad you did not bring more, as we can seat only one to four players. You each have $500 with which to gamble. Try your luck at the Blackjack table? Maybe you'd like to play the slot machines? They are very generous here, I'm told. If not, there is a poker game in the back parlor. You'll receive personal attention from the dealer there."

Casino Games is a collection of three games—Blackjack, Poker, and Slot Machine—for one to four players. Each game uses color graphics. To simulate Las Vegas action, Blackjack follows Las Vegas rules: the dealer (the computer) hits until its score is 17 or better, and splits and doubles are allowed. Poker is five-card draw with a $10 ante and table stakes. Betting rounds happen when the cards are dealt and after the draw. Slot Machine lets you feed any number of coins (dollars) into the slot. The keyboard space bar pulls the handle so that the three wheels go around. Playoffs of various denominations are based on many different combinations.

One to four people can play against each other and the computer. The play is light and spirited, with the graphics and sound keeping both children and adults interested. While Casino Games does not have the intellectual appeal of Adventure or Adventure in Serenia, the games are enjoyable.

Strategy Games

Strategy Games is a set of three classic board games: Checkers, Battleship, and Reversi (Reversi is Othello™). A fourth game in the set, Elusion, was invented especially for IBM.

Checkers for Beginners

Checkers for Beginners is a version of the classic board game that may be as much as 1,000 years old.*

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*No one is sure how old checkers is. The British name for checkers is Draughts, a Middle English word for "the act of movement."

In Checkers for Beginners, color graphics show the different colored squares and pieces. Sound is used to prompt and inform the player about moves, as the single player challenges the computer.

As a referee, the computer enforces the rules strictly: you must jump a piece when you can; you can move and jump only diagonally; pieces move only forward; and kings can move forward or backward.

To rate the computer as a player, the name of the game says it all: "Checkers for Beginners." The computer is a passable beginning challenger. There are easy and advanced modes. The computer has good opening moves in either mode, but it can be rapidly tricked into poor moves. Generally, the game is enjoyable and briefly stimulating.

Battleship

Battleship was inspired by the great World War I sea battles between the Allies and the Kaiser. One player can try to sink the computer's ships, one player and the computer can try to sink each other's ships, or two players can try to sink each other's ships.

The game is played on a 10 by 10 board. The players get four submarines, each 1 unit long; three 2-unit destroyers; two 3-unit aircraft carriers; and one 4-unit battleship. The players take turns firing shots. If the shot misses, the computer "plunks" a star on the board. If the shot is a hit, the screen flashes, a siren is sounded, and the letter for the ship is placed on grid.

This computer version of Battleship is different from the older paper-and-pencil version. In that version each player has fewer ships, but the ships are larger. The shots are also calculated differently. The computer version awards one extra shot per round to the player for each opponent's ship that is sunk. The paper-and-pencil version gives players one shot for every ship they have floating. Because of this, the computer version starts more slowly. However, the end of the game is as exciting as that of the paper-and-pencil version. By the final stages of the computer game, each player is usually firing nine shots per round and searching for the pesky, small submarines.

During Battleship, the computer displays the "hit percentage," which is the number of successful hits divided by the number of shots fired by each player. The total statistics for the game, including numbers of hits and shots fired, are displayed at the end of the game.

Reversi

Reversi is the computerized version of Othello, a strategy game about 100 years old that has gained popularity in the United States in the past twenty years. In this computer version, one player can challenge the computer, or two players can use the computer as the board and referee.

The object of the game is to have more pieces on the board at the end of the game than your opponent has. The computer uses color to distinguish the two players' pieces. Players take turns putting pieces on the 8 by 8 board. Each piece must be placed on the board so that it forms a horizontal, vertical, or diagonal line with one of your own pieces; and traps, or captures, one or more of your opponent's pieces in between the two. The captured pieces are changed to your color and become yours.

To move pieces, the player uses the cursor control keys or a joystick on PC*jr*. When the flashing cursor is over the desired square, pressing ENTER or the joystick button places the piece on the board.

Reversi is a very challenging game. Control of the crucial outer squares and the critical corners determines the outcome of the game. The computer plays a good game but can be duped into giving the corners away. Reversi is probably the best game of the set.

Elusion

Elusion was designed especially for Strategy Games. The object is to make the last move on the board, but this objective is not as simple to achieve as it sounds.

The player or players select the size of the board, either 5 by 5 or 6 by 6. Two players can play each other, or one player can challenge the computer.

Players take turns moving vertically, horizontally, or diagonally. The players can move one or more squares at a time. When players move, the block that is left cannot be moved over or onto. Neither player can move onto a spot occupied by an opponent.

The computer plays a very good game. The key to winning is knowing when to "go for the kill" and attempt to surround your opponent. Going in too early or too late makes you a prime target, and you will lose.

The Arcade Games

The next four games are cartridges for PC*jr* only. Color graphics and sound are used extensively to create the "arcade experience" for PC*jr* owners. Although the keyboard can be used for movement, a joystick is highly recommended. One major feature of the games is a pause function. You can stop the game to take a phone call or get a drink, and then pick up the game where you left off.

Crossfire

Crossfire is a simple game with three levels of difficulty. Insects have invaded your city, and everyone else has left.

Your fleet of three airships can fire insecticide missiles in any of four directions, but there are some minor complications. Because your airships have a limited amount of insecticide, you'll need to reload at an insecticide depot. Meanwhile, the swarm is multiplying and infesting other areas. If you're late with your missiles, the insects will infest the city and you will lose the game. Touching a bug with your airship is also fatal. The score is based on bombing insects and hitting the bonus targets.

(Crossfire may make you cringe the next time you see an Orkin truck.)

Mine Shaft

Mine Shaft is a fast-paced game in which you, the miner, maneuver your miner's car around the treacherous turns and twists in the mine.
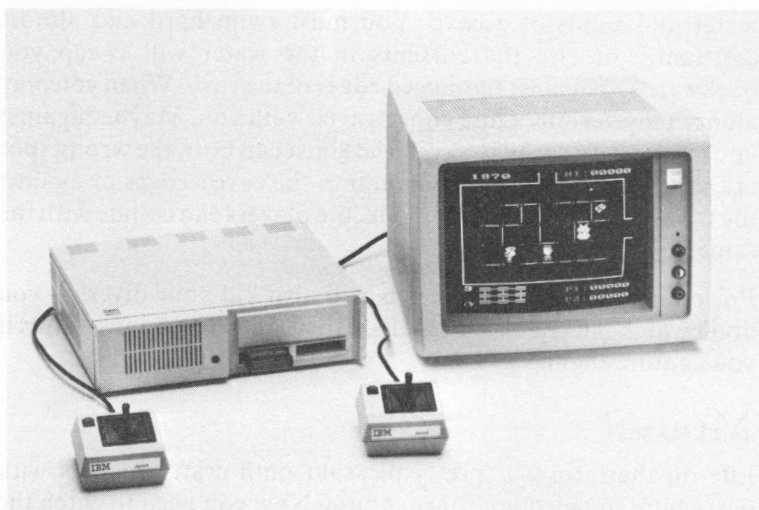
Pictured is a PCjr, *the IBM Joysticks, and Color Display. The picture on the display is from* Mouser, *another arcade-like game for* PCjr. *(Photo courtesy of International Business Machines Corporation.)*

Three types of robot miners are bent on destroying you. One touch from a robot and you're dead! You have a pulsed-laser drill that can destroy the Maintainers (service robots) and the High-Steppers (robots with legs that reach high places). But occasionally the dread Gatherers, who are immune to your laser, come after you.

You try to gather as many diamonds as you can before the robots and the twisty turns in the shaft get you. If you gather all the diamonds or clear the shaft of robots, you advance to the next level. Ten levels are possible, but only the quick will make it past the first level. Points are awarded for gathering diamonds and disabling robots.

ScubaVenture

In ScubaVenture, you lead a team of three scuba drivers. Your mission is to find the keys to treasure chests deep in the murky

water and sands of a cave. You must swim hard and almost constantly or else the currents in the water will sweep you backwards or against the jagged edges of the cave. When you play alone, a mysterious white ghost travels with you. Maybe "against you" is the better way to say it; the ghost can be in the wrong spot at the wrong time and force you into the cave's edges or against the monsters. In two-player mode, the players can collide with the same results.

Poisonous fish and electric eels will also kill your divers if you don't watch out. Look for rare fish; they are worth bonus points if you capture them.

Mouser

Life on the farm was pretty pleasant until crafty rodents with nasty bites invaded your farm house. Now you need to catch the rodents before time runs out.

The nine-room house has barriers (furniture) in each room. You need to be fast and nimble as you try to trap the mice. Because the lights are out in some rooms, you'll need to find the flashlight, but it lights only part of the room. Watch out when you go around corners; touch a mouse and you're dead.

You get points for trapping each mouse. The faster you trap them, the more points you get. However, as you clear the house, you advance into more difficult levels. The mice come back and reproduce even faster, making it more difficult to clear the rooms.

Programs for Graphics

Programs for graphics can be called animation creators, graphics generators, hybrid applications/program languages, or just plain fun. Each program can be used to design pictures. In one case, the program is the electronic equivalent of a slide projector.

Technically, each program is a free-standing applications program that does not need a programming language. Because each program needs a disk drive and 128K of memory, the entry PC*jr* cannot use either.

Animation Creation

In Animation Creation, color graphics pictures can be painted on the TV or monitor's screen, saved on the disk, recalled, and electronically edited. You can create a basic picture, recall it, and make the subtle changes you like. You can store this new picture away on the disk and then create a new picture.

The palette has 16 different foreground colors and 8 background colors. The 254 characters available on the keyboard include special graphics characters like spades, hearts, clubs, diamonds, Greek letters, and other symbols. The picture can be designed for 40- or 80-character lines so that the picture works on TVs, monitors, or RGB monitors.

A second use of the program is to provide a rapid slide show. The pictures on the disk are loaded into memory and displayed in rapid sequence, giving an animation effect. The amount of time between slides can be varied.

The diskette has PC DOS on it, so you can start the computer with it, but you'll still need to buy PC DOS V2.1 to format diskettes that hold the pictures.

Turtle Power

Turtle Power is a tutorial on turtlegraphics, the graphics that Logo and some other languages use. This program falls into the category of "learning by having fun." It captures a youngster's (or adult's) attention because it is fun.

Like Animation Creation, the screen becomes a drawing board. The difference is that the directions to paint are based on the movement of the turtle rather than the point-by-point graphics of Animation Creation. The learner (child or adult) can direct the turtle with one-key commands and also create musical tunes for the turtle.

A valuable feature of the program is that the learner can write or change the "programs." Turtle Power was written in Pascal, not Logo. Many versions of Pascal use the turtle, as does Logo, for graphics. However, the person using the program never seems to be programming a computer.

Turtle Power, like Animation Creation, is not a game, but a pleasant and entertaining way to learn turtlegraphics.

Looking Forward

PC*jr* is a capable game machine. Its graphics and sound are good—maybe not as good as some commercial arcade games, but good enough.

PC*jr* can play games that the arcade can't touch, like Adventure and Adventure in Serenia. The prose games are a hallmark of computers. After you have played Adventure and Adventure in Serenia, there is another group of games from Infocom that boggles the mind. You might call them third-generation prose games. The games are Zork I, Zork II, Zork III, Witness, Deadline, Starcross, and Suspended. They have the flavor of Adventure but are far more complex. The personal satisfaction in solving these prose games is as rewarding as in Adventure.

For arcade-game fans, there are several programs for PC*jr* that will rival the games in the arcades. The list is long and fruitful. You can get just about any video game you want.

All of these arcade-like games and Infocom programs do need a disk drive and 128K. If you have an entry PC*jr*, you'll miss the fun.

In short, there's only one reason for you or your children to go to an arcade. PC*jr* doesn't play pinball. Maybe in time . . . .

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Putting It All Together

Now that you've learned all about the hardware and software that is PC*jr*, it's time to put it all together into a system. A system is simply a complete computer, with all of the hardware, software, and peripherals needed to perform a given task. In this chapter we'll build two systems: a typical home system that includes everything one might want in a starter system, including some hardware ad-ons and a bit of software; and an advanced system that includes all the bells and whistles.

How Much Does It Really Cost?

Like many home computers, the true price of PC*jr* is somewhat higher than the advertised base prices because PC*jr* is sold unbundled. Simply put, the term *unbundled* means that the base price of the computer excludes items that are crucial to the functioning of the machine. For example, the base price of PC*jr* includes absolutely no applications software; yet nearly every user will require at least one application.

Another reason why your PC*jr* will cost more than $669 or $1,269 is that some of the software you want to use may require one or

more of PC*jr*'s options. Not all of PC*jr*'s software will run on the entry model. The following list shows the equipment that is needed to use each of PC*jr*'s software products.

Programs that will run on PC*jr* entry system:

Cassette BASIC
Cartridge BASIC
Crossfire
Mine Shaft
Mouser
ScubaVenture

Programs that require a disk drive (DOS provided on disk; disk does not include all DOS utility programs. Some of these programs may require 128K RAM as well.):

Adventure
Adventures in Serenia
Animation Creation
HomeWord
Turtle Power
Personal Communications Manager

Programs that require Cartridge BASIC and a disk drive (DOS provided on disk; disk does not contain all DOS utility programs. Some of these programs may require 128K RAM as well.):

Adventures in Math
Bumble Games
Bumble Plot
Casino Games
Juggles' Butterfly
Monster Math
Strategy Games

Program requiring a disk drive, DOS 2.1, and Cartridge BASIC (Some of these programs may require 128K RAM as well.):

Arithmetic Games

Programs requiring a disk drive, DOS V2.1, and 128K RAM:

BASIC Compiler
Diskette Librarian
Dow Jones Reporter
Home Budget, *jr*
Logo
Macro Assembler
Multiplan
Personal Editor
Time Manager
VisiCalc
Word Proof

Programs requiring a disk drive, DOS 2.1, 128K RAM, and an 80- column display:

EasyWriter 1.15
FileCommand
pfs:FILE
pfs:REPORT
Professional Editor

You may have noticed that nearly all of PC*jr*'s home management software, and much of the education software, requires a disk drive and 128K RAM. Keep this in mind as we build our sample systems.

You may be surprised by the cost of the units we're about to design. One purpose of this chapter is to show you that, in all likelihood, the PC*jr* you take home will cost more than $669 or $1,269.

A Typical System

Our typical system begins with an enhanced IBM PC*jr* that includes a disk drive and the 64K Memory and Display Option (bringing the unit's total memory to 128K). This system retails for $1,269. A serial port and Cassette BASIC are included in this base price. Because we purchased a disk drive, we also need Cartridge BASIC ($75) and DOS 2.1 ($65).

We decided to start with the enhanced PC*jr* for several reasons. First, a great deal of the software for PC*jr* requires a disk drive, especially software that has been adapted to PC*jr* from the IBM PC. In our case, a drive was essential because several programs we wanted to run, including Multiplan, require a disk drive.

Because we added a disk drive, we needed to add more memory to PC*jr*. Although it would be possible to have a disk drive and DOS 2.1 on a PC*jr* with only 64K of RAM, in most cases that is not a practical configuration. If you buy a disk drive, you should expect to buy the 64K Memory and Display Option as well.

Nearly any application for the computer requires more that 64K of RAM. Of the original 64K, 16K is reserved for the video buffer. This reduces the usable portion of RAM to 48K. In addition, DOS 2.1, which is required if your PC*jr* has a disk drive, uses another 24K, reducing the usable space to only 24K. Many PC*jr* programs will not run in only 24K of RAM. Suddenly, the 64K that looked so spacious is beginning to look tight.

We've decided to use our home TV for video display, so we don't need to buy a separate monitor. But we do need an IBM PC*jr* Connector for TV, which sells for $30.

Since we want to play a few games on PC*jr*, we'll buy two joysticks. Don't forget, HomeWord (which we'll buy in a minute), can also use the joysticks. They sell for $40 apiece.

Software

Computer manufacturers are notorious for not including the price of needed software in the advertised price of the computer. In fact, software is a critical part of any computer system. In some cases, the cost of the software can exceed the cost of the basic machine. (Just ask anyone who bought an Atari VCS home entertainment computer for $125 and has since spent hundreds of dollars on game cartridges.)

We'll buy a modest amount of software for our PC*jr*. Remember, we've already added two programs—PC DOS 2.1 and Cartridge BASIC—to our system. We also want several application programs for PC*jr*, including Multiplan ($250), HomeWord ($75),

Crossfire ($35), Mine Shaft ($35), Bumble Games ($40), and Bumble Plot ($40). This group includes programs from all of PC*jr*'s application groups: personal management, education, and entertainment. The total cost of our applications is $475, plus $10 for a set of blank keyboard overlays that we can customize for use with the programs.

Including the system's software (BASIC and DOS), our software bill is $625. We didn't spend extravagantly—we bought a couple of personal management tools, two games, two entertainment programs, and the required system software. When we go back to the store to buy software for our "loaded" system, we'll be more extravagant.

Printer

Because hard copy printouts of the work we do with our computer are virtually a must for all applications other than games and some educational programs, we'll need a printer.

The least expensive printer for PC*jr* is the IBM PC Compact Printer, which sells for $175. For the price, the Compact Printer is remarkable. Unless you need a very fast printer or letter-quality output, the Compact Printer will meet most of your needs. (Letter quality means that the text produced by the printer looks as if it were produced on a high-quality typewriter.) Because the Compact Printer uses PC*jr*'s serial port, no additional interface device is needed.

This system meets the basic needs of a typical PC*jr* user. It would, for example, be just enough computer for the Roberts we met in the introduction. Actually, this system lacks a few programs the Roberts were using. The total price of our system, including printer, is $2,179. This price does not include sales tax or the cost of a television set. We assume you already have a TV. Compare the price of this typical system to PC*jr*'s advertised entry price of $669—quite a difference, don't you agree?

We could save a few dollars by not buying quite as much software. We could leave Bumble Plot on the shelf and save $40; if we left the game Mine Shaft out of the package, we'd save another $35. However, it has been our experience that most people skimp on

software when they buy their system, only to return to the store within a few weeks to buy more programs. This is especially true with home computers because games and, to some extent, educational programs are quickly mastered.

We could also economize by not buying a printer. However, one of our primary applications, Multiplan, virtually demands a printer. If we had a printer available to us at the office or at a neighbor's house, we might get by without one for a while. Eventually, though, most computer users buy printers.

We could save $80 by not buying the joysticks. Every PC*jr* game will work without joysticks even though joysticks are preferred. Remember, though, that it is very difficult for two players to use the keyboard at the same time. If you are going to compete, you need joysticks.

A Supersystem

There are still other options we'd like to add to our PC*jr*. If we want a faster printer, we could substitute the IBM Graphics Printer for the Compact Printer. The Graphics Printer requires the IBM PC*jr* Parallel Printer Attachment and the Printer Cable for Parallel Printers. The total cost of the package is $749, or $574 more than the Compact Printer.

If you want to produce letter-quality output, you'll need the NEC Spinwriter Model 3550 printer or a similar printer. The NEC 3550 is a good basic letter-quality printer, adequate for all but the most rigorous usage. Like the Graphics Printer, the NEC 3550 requires a parallel port and cable. The NEC 3550 sells for $2,290, plus $154 for the adapter and cable. If you substitute this printer for the Compact Printer, the NEC adds $2,269 to the system cost.

Display

Although your home TV is adequate for many PC*jr* applications, it has some limitations. For one thing, a home TV can display only 40 characters of text per line. Because the average typed page is at least 60 characters wide, word processors usually work best with an 80-column screen. Thus, a home TV is not the best display for word processing.

Home TVs do not have the resolution of more expensive monitors, so home TV graphics are not as clear, and alphabetic characters on a TV are less well defined than on a monitor. A TV will be adequate for most home entertainment and educational software and can be used in a pinch for most home management programs, but the TV is not sufficient for steady use of word processing or electronic spreadsheeting.

For these reasons, we've decided to equip our "loaded" PC*jr* with an IBM Color Display. This adds $680 to the system price. Because we want text with 80 characters per line, we also need the IBM Adapter Cable (which costs $20) for RGB Color Displays. Since we're not going to use our TV anymore, we don't need the Connecter for TV. Dropping this device saves $30. If we didn't need the 80-character capability, we could attach the color monitor directly to this device.

Modem

Because we intend to use our super PC*jr* to communicate with other computers, we need a modem. We can buy either an IBM PC*jr* Internal Modem ($199) or a Hayes Smartmodem 300 ($279) or Smartmodem 1200 ($669).

The IBM PC*jr* Internal Modem is adequate for all but the most extensive communications applications. Because the Internal Modem is designed specifically for PC*jr*, it is much easier to install and use than other modems (not a small consideration). The only limitation of the Internal Modem is speed. Transferring large amounts of data at 300 baud (the Internal Modem's top speed) can take a long time. If your application demands more speed, you should consider the Hayes 1200. Our communications needs are relatively limited, so we'll select the IBM modem on the basis of price.

The only difference between the two Hayes models is the speed at which they transmit data. The Hayes 1200 transmits at 1200 baud, 4 times faster than the Hayes 300. If we buy a Hayes modem, we'll also need an RS-232 Cable for Modem. This option costs $47.

Software

If we are to take advantage of our new modem, we need a communications software product. The IBM PC*jr* offers two: Personal Communications Manager and Dow Jones Reporter. As these two serve different functions, we'll buy both. The total cost of these two is $200.

We also need data management software for our PC*jr*. PC*jr* offers an excellent pair of personal data managers: pfs:FILE and pfs:REPORT. These two programs work together. The pfs:FILE program stores information in an easily retrievable form; pfs:REPORT works with pfs:FILE to create formatted reports. The two programs together cost $265.

We'll also buy the Time Manager program. This software tool helps keep track of appointments, to-do tasks, and expenses. It can be used in the home or in the office. The cost: $100.

The Bottom Line

The total price of our advanced system with the IBM Graphics Printer is $4,187. With the letter-quality NEC 3550 printer, the tab is $5,882.

Although this seems like quite a bit, our advanced PC*jr* is far less expensive than an IBM PC with similar capability. An IBM PC system with 128K, one disk drive, an IBM Color Monitor, the IBM Graphics Printer, a Hayes 300 modem, and the same dollar amount of applications software that we bought for the "loaded" PC*jr*, would cost over $5,000, or $1,300 more than the PC*jr* system. You may be wondering why anyone would buy an IBM PC when you can get the same capabilities for so much less in a PC*jr*. We'll deal with this question in Chapter 10.

Economizing

Many of the expansion options offered for PC*jr* by IBM are competitive with similar devices manufactured by other suppliers. For example, at $140, the IBM 64K RAM and Color Display Option is less expensive than many 64K RAM cards offered by other manufacturers. The IBM Compact Printer,

which sells for $175, is probably the lowest cost printer you can buy for PC*jr*. Similarly, the PC*jr* Internal Modem is one of the least expensive modems available today.

However, if you want the capabilities offered by the "loaded" system we've designed, but need to save some dollars, you can get these capabilities at a lower cost.

Alternative Monitors

If you want better quality video than that offered by your home TV set, but don't want to spend nearly $700 for an IBM Color Display, you can buy a color or black and white monitor from some other manufacturer. For example, instead of buying the IBM Color Display, you could buy a color display made by Amdek Corporation, which sells a very good RGB color monitor for about $529, roughly $150 less than the IBM Display.

You could buy a composite monitor for PC*jr* for between $350 and $400. A composite monitor might be a good choice if you don't want to use your home TV with PC*jr*, yet don't need to display 80 characters per line or have high-resolution characters. Because these monitors cannot support an 80-column display, however, they are not suitable substitutes for an RGB monitor.

Another option would be to use a high-quality black and white (or black and green or amber) monitor with your PC*jr*. Some black and white monitors cost as little as $100. Good monochrome (single-color) displays like these are available for as little as $150, and very good displays of this sort can be had for about $250.

Monochrome displays tend to do a better job than color monitors of displaying letters and numbers. This means that for some applications, including word processing and electronic spreadsheeting, a monochrome display may be superior to the color display.

Many monochrome monitors will also display graphics. Naturally, a monochrome display will not show color. If you have a color TV, though, you can use it for graphics games and the monochrome display for other purposes.

Printers

The NEC 3550 that IBM suggests for PC*jr* is a very good letter-quality printer. Unfortunately, it is also fairly expensive. Other letter-quality printers are available at much lower prices. For example, the Daisywriter™ from Computers International costs $1,495. The Smith Corona Printer TP II™ sells for just $895.

These printers offer most of the capabilities of the NEC 3550. The main difference between these printers and the NEC is speed. The 3550 prints about 35 characters per second; the Daisy and the Smith Corona print at 20 and 12 characters per second, respectively. If you intend to use your printer only for occasional letters and short documents, the speed will not be a problem. If your work involves long documents or frequent heavy printing, however, you would probably be better off with the NEC.

A word of caution: because of differences in communications protocol, control codes, and cabling between printers, there is no assurance that a given printer (including those mentioned above) will work with your PC*jr*. Don't buy any letter-quality printer for your PC*jr* until you've seen it work.

Conclusion

As you can see, a useful PC*jr* system can cost quite a bit more than the advertised base price of $669. Many of the items considered options by IBM are really essential to the proper use of the computer. After you add all the software and hardware options we think you'll need, a PC*jr* can cost as much as $2,100, and a loaded system can be even more.

Lest you accuse IBM of being unfair, though, we should point out that *all* of the companies in the microcomputer industry play this game. In the next chapter, we'll compare PC*jr* to other popular home computers. These machines offer a wide range of standard capabilities and expandability. The prices of these machines vary widely. Some are sold unbundled, and others are more or less complete. You'll want to keep this in mind as we compare PC*jr* to other popular home computers.

10
Where PC*jr* Fits

When the first IBM PC was introduced in 1981, many industry experts said the machine was too late to be important to the microcomputer industry. However, the original PC revolutionized the industry, closing the door on the era of 8-bit computers and creating a new 16-bit market. Earlier machines continued to sell well, but the IBM PC was the new standard.

This time the experts fully expect the PC*jr* to be a major force. Even before it was introduced, the PC*jr* had a strong impact. Months before the machine was introduced, the fear of IBM's entering the home computer market drove down the stocks of rival firms.

If you are still in the market for a home computer, the comparisons in this chapter will help you decide which one is better for you. Because many readers may be trying to decide whether PC*jr* or the original PC is right for them, this chapter also compares PC*jr* to the PC.

The Home Computers

Like the IBM PC, PC*jr* is being introduced into a crowded market. The main competitors in the home computer market-

place—Texas Instruments, Atari, Commodore, and Coleco—have all been selling very strongly for some time.

What Is a Home Computer?

Home computers come in all shapes and sizes. Some are simple game-playing machines. Others, including the Commodore 64 and the Coleco ADAM, are powerful, full-feature computers. Still others, like the IBM PC and the Apple II, are machines that can also double as business computers.

The term *home computer* is difficult to define. Experts who use price as the primary guide call any machine that sells for less than $1,000 (or in some cases $1,500) a home computer. These rather arbitrary dividing lines group together machines as diverse as the Apple II, the ColecoVision, the Commodore VIC-20, and the PC*jr*.

One of the biggest problems in categorizing personal computers by price is that they are so frequently sold "unbundled." The base price advertised is for a stripped-down model; but several hundred dollars' worth of additional equipment is probably required to get the most out of the computer.

A Broad Definition

In general, a home computer is one used primarily for entertainment and educational software, designed to attach to a TV set, and priced under $1,000. If the computer is expandable, the expansion is not sufficient to make the machine a "business system."

PC*jr* fits this category pretty well. The base computer sells for $669, the expanded version for $1269. The machine offers most of the tools needed in a complex home computer—a disk drive, 128K of memory, two program cartridge slots, BASIC, and a serial port for attaching additional peripherals. IBM provides the other items you might want, including a modem, a parallel port, and a printer, at competitive prices.

Making Comparisons

The home computer market is really several markets. Different classes of home computers are sold to various parts of this very large and diverse market. For purposes of comparison, we'll divide the home computer market into three classes: entertainment computers, full-feature computers, and transplants. Entertainment computers are machines that essentially only play games. This group includes the Atari 2600/VCS and 5200, the ColecoVision, the Mattel Intellivision, and a variety of lesser known machines.

Full-feature computers offer a level of performance not available from game computers. The low end of this group includes the Commodore VIC-20, the Atari 600XL and the Timex/Sinclair 1000. At the top are the Commodore 64; the Atari 800XL, 1200XL, and 1400XL; and the Coleco ADAM.

Transplants are computers like the Apple II and IBM PC— machines that are not primarily intended for use in the home but are nevertheless used there for a variety of reasons. These computers are, in effect, transplanted from the business and office environment to the home market. Transplants provide even more computing power and software than the full-feature machines.

Entertainment Computers

The traditional home computers are the entertainment systems like the ColecoVision, the Atari 2600/VCS and 5200, and the Mattel Intellivision. These systems are defined by their limited capabilities for applications other than entertainment and by their price—typically under $100.

The first home computer was the game PONG, developed by Alan Bushnell, founder of Atari. PONG was the hit of the 1975 Christmas season. It was expensive and did just one thing, but it was the only game in town.

In 1977, Atari introduced its Video Computer System (VCS). The VCS was the first home computer that offered software on interchangeable cartridges. For a long time the VCS had no competition. This computer was the first to bring into the home

Pictured is the ColecoVision™ Video Game System. (Photo courtesy of Coleco Industries, Inc.)

popular arcade-type games, like Space Invaders, PacMan, and Asteroids. Literally hundreds of game cartridges are available for this system.

Although the VCS has been constantly copied and improved, it remains the most popular home entertainment computer ever sold. Today, though, it offers far less capability than other home entertainment systems at a price—$129—that will buy a good full-feature computer.

Other manufacturers, including Coleco and Mattel, jumped into the home computer market after Atari. ColecoVision and Intellivision have taken aim at the popular VCS in the game-only market, offering higher-resolution graphics and more sophisticated games. Mattel even offers a voice synthesizer, the IntelliVoice Module, for the Intellivision. Coleco sells an adapter for $160 that will allow the ColecoVision to use Atari VCS

cartridges. These two computers originally cost close to $300 but can now be purchased for as little as $69.

Although these machines are superior to the Atari 2600 and offer very exciting games, they are simply not as flexible as full-feature computers like the Commodore VIC-20 and the TI-99/4A. Even at their current prices, we think you'd be making a mistake to buy one of these systems.

There is some movement, however, to enhance these basic home computers into more powerful systems. Coleco recently an-
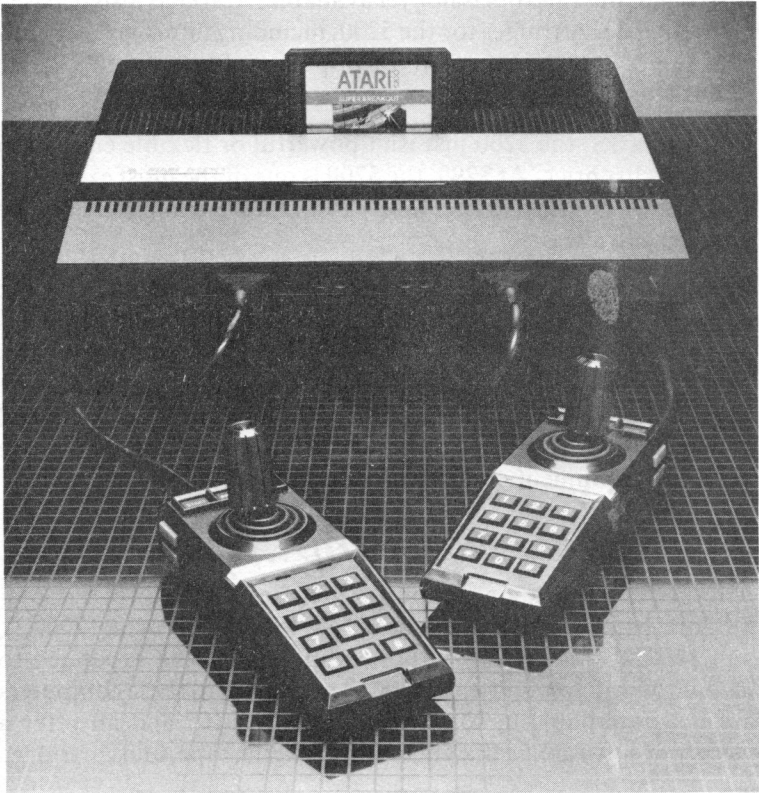
The Atari 5200 (Photo courtesy of Atari, Inc.)

nounced ADAM, a full-feature computer that is, in fact, an enhancement of ColecoVision. (ADAM will be discussed in this chapter.) Mattel has been promising major enhancement, in the ADAM class, for Intellivision.

In response to changes from ColecoVision and Intellivision, Atari has supplemented the VCS with the Atari 5200 Super-system. The 5200 offers better graphics and more sophisticated games than the VCS. Unfortunately, because Atari redesigned the program cartridge slot on the 5200, none of the Atari VCS's cartridge software can be used with the 5200. Atari has promised an adapter module for the 5200 that will allow it to read VCS cartridges, but this tool is not yet available. Atari has also released a dozen or so cartridges for the 5200, including improved versions of some of the company's most popular software. Other game publishers are hustling to participate in the 5200 market.

Like the VCS, the 5200 just isn't powerful or flexible enough to justify its list price. At $299, the 5200 is one of the most expensive game units on the market. Many full-feature computers can be purchased for less.

Even though all of the home entertainment systems offer the potential for hours of fun for children and adults, none of them is in the league with PC*jr*. If you are looking only for a computer on which to play video games, then one of these machines may be sufficient. However, if you want to do anything else—personal management, education, communication, programming—these home entertainment computers are simply not up to the task.

Full-Feature Computers

Another class of home computers includes the TI-99/4A; Commodore 64; ColecoVision; and Atari 600XL, 800XL, 1200XL, and 1400XL. Most full-feature computers can be expanded to include disk drives and up to 64K of memory. All these computers are programmable in some version of BASIC, and all offer a variety of software media, including diskette, tape, and cartridge.

These computers also offer a fairly wide range of software in the major applications areas: entertainment, education, and home management. Still, the primary application for this class of

machines is games. These machines all sell for between $50 and $1,000, but the prices vary so widely that it is nearly impossible to peg them down precisely.

Timex/Sinclair

It is possible to obtain a full-feature computer for less than the cost of an entertainment system. The Timex/Sinclair 1000, a programmable home computer with limited power, can be purchased for under $50. The T/S 1000 is the younger brother of the Sinclair ZX80, developed by Clive Sinclair, an early micro-computing pioneer. Both machines were developed to provide home users with a low-cost introduction to computing.

Calling the Timex/Sinclair 1000 "full feature" stretches the truth a bit. Although this tiny computer uses an 8-bit Z-80 micro-processor, it offers only limited memory (internal memory is just 2K, expandable up to only 16K), no disk drive or cartridge slot,

The Timex/Sinclair 1000 home computer. (Photo courtesy of Timex Corporation)

and very little software. The T/S 1000 can be used only with a home TV. The computer does, however, offer a good version of BASIC (stored in ROM) and some simple graphics.

In spite of these limitations, however, the T/S 1000 has been extremely popular. Because the price is so low, many individuals bought the machine on impulse just to learn about home computing. Thousands of T/S 1000s were sold last Christmas and early in 1983. Because the T/S 1000 is so limited, and because so many people bought them impulsively, many of the machines are now stored on the top shelves of closets. Whether or not these T/S 1000 owners have "traded up" to a more complete system is unknown.

Still, buying a T/S 1000 is probably the least expensive way to get involved in computing. If you are unsure about home computing and want to ease into the market, the T/S 1000 might be a good choice. But don't expect the T/S 1000 to do the tricks PC*jr* can do.

Commodore VIC-20

Commodore is one of the earliest participants in the home computer game. The first Commodore computer, the PET, was not particularly successful. PET was unattractive, expensive, and unreliable. Compared to the Apple II and TRS Model I (with which PET competed), this computer was not a winner.

The VIC-20 was Commodore's attempt to gain back a significant share of the home computer market. When first introduced in 1981, the VIC moved slowly, in part because of its price ($300), and in part because of its small software library. However, Commodore quickly lowered the price (a VIC-20 can be obtained now for less than $100), offered more expansion options, and turned the VIC-20 from a flop into one of the largest-selling computers of all time.

At $100, the VIC-20 is another low-cost home computer. Unlike the Timex/Sinclair 1000, however, the VIC-20 offers a wide range of expansion options and software.

The Commodore VIC-20 (Photo courtesy of Commodore Business Machines, Inc.)

Hardware

The VIC-20 uses the MOS Technologies 6502A microprocessor, the same chip used by the Apple II and the Atari line. Like most home computers, the VIC offers a good BASIC interpreter. BASIC is stored in the 20K of ROM that is standard with the computer.

One of the nicest features of the VIC-20 is its ability to use software delivered on cartridge, tape, or diskette (with the optional disk drive). The most popular addition to the VIC-20 is a cassette tape recorder that allows the VIC to retrieve and store information on cassettes.

Unlike many home computers, the VIC-20 features a full-travel, 60-key keyboard with four special-function keys. Because Commodore uses special shift keys, it is possible to type graphics characters directly onto the screen and create graphics very easily.

The VIC was one of the first low-priced home computers to offer a disk drive. The Commodore Model 1540, with a 170K capacity, for $395, is designed for use with the machine. Commodore also offers an inexpensive printer, the 1525. Another popular addition

to the VIC-20 is the VICmodem, a telecommunications device that plugs directly into the back of the VIC-20 computer. All in all, the VIC-20 is far more expandable than most home computers in its price range.

An important limitation of the VIC-20 is its relatively small RAM size. In a standard configuration, the VIC has only 5K of RAM. Although the VIC's RAM can be expanded to 32K, the expansion costs $210. Another limitation of the VIC is its screen size. The computer will only display 22 text characters per line.

Software

The VIC-20 has a large library of programs, mostly in the areas of education and entertainment. There are several popular personal management programs sold for the VIC-20, including a very good (within the limits of the computer) word processor, the Quick Brown Fox. With this library of software, the VIC is remarkably flexible for an inexpensive computer.

The VIC was one of the first computers to be marketed outside computer stores, by large department store chains such as K Mart and toy stores like Toys-R-Us. In the noncomputer store market, the VIC-20 provides significant competition for both video computers and full-feature machines like the TI-99/4A.

The popular price of the VIC has led to literally millions of sales. Just a few years ago a computer keyboard alone cost twice the current selling price of the VIC 20.

Nevertheless, the VIC-20 has some limitations, when compared to machines costing only $100 more than the VIC. We'd recommend that you pass by the VIC-20 in favor of other more powerful computers like the Commodore 64 or PC*jr*.

Commodore 64

The Commodore 64 is the bigger brother of the popular VIC-20. Although the machines look alike and use similar components, the 64 offers greater capability than the VIC. The Commodore 64, a very sophisticated machine, can be purchased in its simplest version for just over $200.

Commodore 64 offers a full range of entertainment, home management, programming, and educational software. This computer is also capable of significant hardware expansion. As its name implies, the Commodore 64 offers 64K of RAM, which makes it versatile. Because of its large memory size and relatively low price, the 64 has become a very popular starter microcomputer.

This machine uses a 6510 CPU, a chip that is similar to the 6502 used in the VIC-20 and other computers. Many different programs written for the Apple and Atari can be translated to the 64 with relative ease. Although the 64 CPU is similar to that in the VIC-20, only a few programs can be used on both machines without alteration because of small differences between the two computers. Still, the 64 has a large family of software for personal management, education, and entertainment. Notable programs for the 64 include The Quick Brown Fox, a word processor; and CalcResult, a good electronic spreadsheet.

Like most home computers, the 64 offers a program cartridge slot. Much of the computer's game software is sold on ROM cartridges that plug into this slot. Commodore has also introduced a cartridge for the 64 that contains a Z-80 CPU. This cartridge allows the Commodore 64 to use the CP/M operating system with its large library of business applications programs. The availability of CP/M programs for the 64 makes it competitive with PC*jr*, which can use PC DOS programs, and the Apple II, which uses its own large library.

As with most home computers, the Commodore 64 is designed to be attached to a home TV. Unlike the others, including PC*jr*, however, the 64's RF modulator is built in to the machine. Like PC*jr*, the Commodore 64 offers a standard 40-character-wide video display. Because the 64's line length cannot be extended like PC*jr*'s, the Commodore is limited as a word processor. The computer does offer a 320-by-200 dot, high-resolution graphics display.

Like the VIC-20, the 64 can be attached to mass storage devices, including tape and disk drives. Commodore's 1541 disk drive is an inexpensive add-on to the computer. This drive has a 170K capacity, more storage than some popular business computers.

The Commodore 64 (Photo courtesy of Commodore Business Machines, Inc.)

Two other popular additions to the 64 are an inexpensive printer, Model 1525, manufactured by Commodore, and the VICmodem described earlier.

The Commodore 64 is one of PC*jr*'s main competitors. It offers fairly high memory, hardware expandability, and a large software library at an extremely low price—in some cases less than $200. Still, there are some important differences between the machines. For one thing, the Commodore has a maximum memory capacity of 64K, while PC*jr* offers a maximum of at least 128K. Some programs that can run on PC*jr* cannot run on the Commodore.

Another advantage offered by PC*jr* is its compatibility with the IBM PC. This compatibility makes a substantial library of software available and assures the availability of still more programs in the future. Although the 64 offers a large library of programs and has access to the CP/M library, the 64 is not directly compatible with any more powerful business computer.

Commodore has recently experienced some serious difficulties with product reliability. Some dealers are reporting DOA (dead on arrival) rates as high as 20 percent. If these reports are accurate, Commodore has a serious problem. Assuring the

quality of its computers is the major challenge ahead for Commodore.

On the other hand, at $220 for a basic unit, the Commodore is less than one-third the price of the entry PC*jr*. When you add a disk drive, a printer, and some software to the unit, it is still far less expensive than the PC*jr*. Because the two machines are very close in capabilities, the Commodore's lower price is a real advantage.

Commodore 128

An announced, but as yet unshipped, 128K version of the Commodore 64 is the Commodore 128. This version is supposed to offer all the attractive features of the Commodore 64— expandability, software, and low price—with 128K of RAM. If Commodore does follow through with this new machine, it will provide even more competition for PC*jr*.

The TI-99/4A

Some manufacturers are reacting to the increased competition in the home computer market by introducing new machines or by upgrading their current offerings. Texas Instruments has taken a more radical strategy. On Saturday, October 28, 1983, TI announced it was dropping out of the home computer market altogether.

The TI-99/4A is a real rags-to-riches-to-rags story. The computer started slowly, largely because it was too expensive and didn't offer enough software. Following a strategy TI used in the calculator market, the company decided to build its market share by dropping the price of the unit. When the TI-99/4A was first introduced in 1982, it sold for $995. The price fell steadily until, by early 1983, a 99/4A could be purchased for around $100 after rebates. Now that the TI-99/4A has been discontinued, it can be purchased for as little as $50.

Even at the prices TI was charging before the 99/4A was discontinued, the machine was selling below its direct manu-facturing cost. Because other home computers (especially the Commodore 64) were continuing at the low price level, there was

Pictured is the Texas Instruments 99/4A System. (Photo courtesy of Texas Instruments, Incorporated.)

no end in sight to TI's losses. The company simply decided to get out of the marketplace.

The 99/4A uses the 16-bit TMS9900 microprocessor, the same chip used in the Texas Instruments 9900 *mini*computer. Although the TMS 9900 is a 16-bit processor like the Intel 8088 used in PC*jr*, the TI has a maximum RAM capacity of only 48K. The 99/4A has 16K RAM standard.

Like the Commodore and PC*jr*, the TI can use software stored on diskette, cassette tape, or cartridge. The computer also offers over 80 programs of applications software.

One early mistake by TI was not releasing to outside publishers important information about the architecture of the 99/4A cartridge. For this reason, most software published for the TI by outside software houses is sold on tape. TI's move significantly slowed the development of third-party software for the 99/4A.

The TI-99/4A programming library also offers a large assortment of programming languages, including BASIC, which is built into the machine's 26K ROM assembler, LOGO, PILOT, and UCSD p-System Pascal.

The disk drives made by TI for the 99/4A have a capacity of only 70K, but the computer can manage up to three drives. Each drive costs $500. There are several other expansion options available for the 99/4A: an expansion chassis capable of supporting up to three disk drives, an RS-232-C card, and other peripherals.

The 99/4A can generate a variety of different sounds. Like PC*jr*, the 99/4A has the ability to generate more than one tone at a time, so the computer can be used to create serious music. Another option, a realistic voice synthesizer, may be added.

Of the two printers that TI offers for the 99/4A, the most popular is a dot matrix printer manufactured by Epson. (Epson also produces the IBM Graphics Printer.) Data communications can be achieved through a modem, which is attached to the computer through the expansion chassis, and an RS-232-C card.

It is unfortunate that the TI-99/4A has been discontinued. The computer offers surprising power and flexibility at a very low price. But buying a TI-99/4A today would be an invitation for trouble. Although the machine is currently very popular (largely because it is so inexpensive), before long there will be little new software for the machine, and parts for the computer will be hard to find.

If you want a very inexpensive home computer, the authors suggest that you buy one of the Commodore machines. The VIC-20 can be purchased for only a little more than the TI-99/4A. Although $55 may seem to be a very good price for a home computer, in the long run, buying a TI-99/4A may be a big mistake.

Atari

Atari has been prominent in the home computer market since the earliest days. Atari was the first firm to offer both a video game system and a home computer line. Today Atari offers four home computers: the 600XL, 800XL, 1200XL, and 1400XL.

Atari 400 and 800

The earliest Atari home computers were the 400 and the 800. Both machines used a 6502 microprocessor and offered a wide variety of game program cartridges, including many of the popular Atari arcade-type games.

Both computers offered 16K of RAM, but the 800 was expandable to 48K. The 800 could also be used with either a home TV or a color monitor. In addition, the 800 offered two cartridge slots, whereas the 400 offered only one. Both the 800 and the 400 could be expanded with a disk drive and a printer, but the 400 was rarely used with these peripherals.

Right now the Atari 400 is selling for $119 (before a $50 rebate from Atari), and the 800 is selling for $359 (before a $100 rebate). The 400 and the 800 are in the process of being replaced by the new Atari XL line of home computers.

The Atari XL Line

The new Atari computers, the 600XL, 800XL, 1200XL, and 1400XL, are direct descendants of the 400 and 800. Like the older machines, the XL series uses the 6502 microprocessor. Like the 400, the 600XL offers a standard 16K of RAM with the capability of being expanded to 64K. The 800XL, 1200XL, and 1400XL all have the standard 64K. All come with built-in RF modulators that make the machines easy to attach to your TV set. All also come with Atari BASIC (a version of Microsoft BASIC) on ROM and, like PC*jr*, offer multivoice sound.

Each machine in the line offers some capability not available on the lower machines. For example, the 800XL has a port that allows an expansion chassis to be attached to the computer. The 1400XL offers a voice generator and a built-in modem.

The most noticeable difference between the old and the new is styling—the machines are now packaged in an attractive, modern, black keyboard-style cabinet. In addition, all the computers feature a full-travel keyboard, which is a definite improvement over the 400's membrane keyboard.
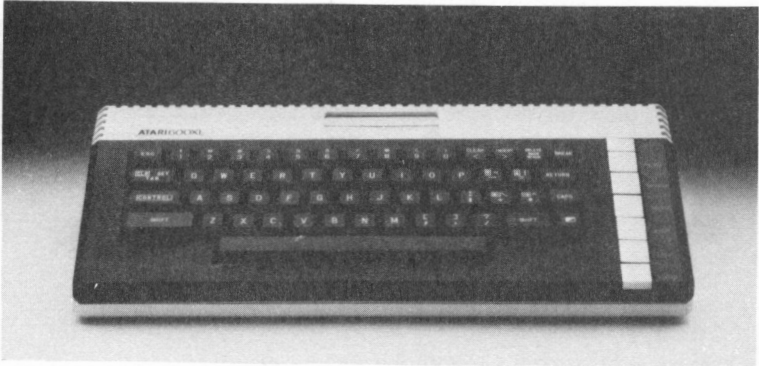
The Atari 600XL (Photo courtesy of Atari, Inc.)
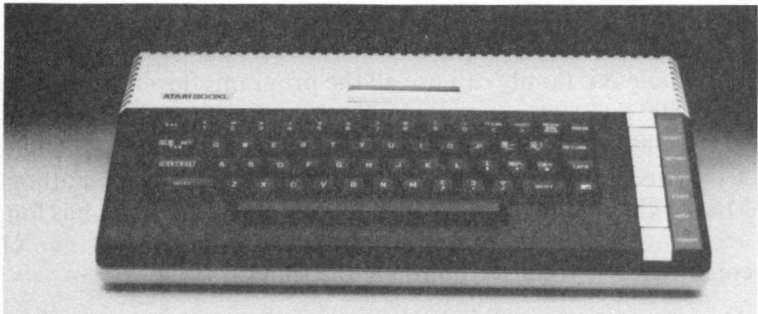
The Atari 800XL (Photo courtesy of Atari, Inc.)

The XL line continues Atari's tradition of excellent color graphics capabilities. All the machines offer a 320-by-192-dot graphics display with 256 colors and a 40-character-by-24-line text display.

Atari has introduced a new disk drive, the model 1050, for the XL computers. The 1050 offers 127K of storage. The line also includes two new printers: the 1025, a dot matrix printer, and the 1027, which offers letter-quality output.
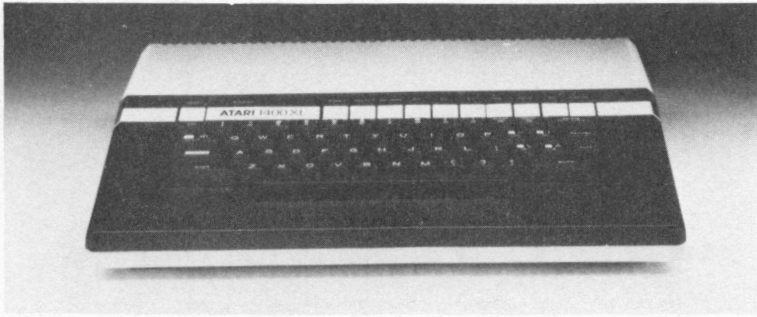
The Atari 1400XL (Photo courtesy of Atari, Inc.)

The whole XL family can use all the programs developed for the Atari 400 and 800, most of which are intended for entertainment or education. Atari's family of education software includes programs like Star Raiders (a personal favorite of the author), Missile Command, Centipede, and Pole Position. Atari has long been the leader in personal computer games, and the XL computers seem sure to continue the trend.

Atari has been increasing the library of personal management software available for the XL line. This library includes Atari-Writer, a good word processor; Home Filing Manager, a data manager; and VisiCalc, the popular electronic spreadsheet that is also available on PC*jr*.

The prices of some of the new XL computers are still pending. The 600XL has a suggested retail price of $199. The price of the 800XL is $299, but it can be obtained for less by mail order. The 1200XL sells for $499, which seems too high in relation to the 800XL. (In fact, there is a rumor that the 1200XL is either discontinued or is about to be.) No price has been announced for the 1400XL. Atari is known for frequent price changes—both up and down. The company recently announced dealer price increases for the 600XL and 800XL. The effect that those increases will have on the prices quoted is unknown.

For several years, Atari's home computers were *the* choice for entertainment. Atari has been hurt recently by the popularity of the Commodore 64 and the TI-99/4A. It looks as if PC*jr* will also threaten Atari.

Although the upper end of the Atari family and PC*jr* are similarly priced, the IBM machine offers significantly more power. For one thing, PC*jr* can be expanded to use 128K of RAM. And, as we have mentioned before, PC*jr* is compatible with the IBM PC. This means that PC*jr* will have the edge in the area of personal management software.

On the other hand, like the Commodore family of computers, the new Atari line is far less expensive than PC*jr*. You could buy an Atari 800, plus a disk drive and a program or two, for about the same price as the entry PC*jr*. If you plan to use your home computer primarily to play games, but want more personal management power than the Commodore 64 offers, the Ataris may be for you.

Coleco ADAM

The competition from full-feature home computers is causing the manufacturers of entertainment systems to adopt some interesting new strategies. Coleco, for example, is expanding the power of its ColecoVision system with the new ADAM. Introduced at the 1983 Consumer Electronics Show, ADAM became an instant hit.

ADAM is sold in two versions with exactly the same capabilities: a completely self-contained computer and an upgrade to the ColecoVision. ADAM was introduced at a price of $600 for the complete system. The complete ADAM now sells for about $750 (based on the company's November 11, 1983, price rise). The upgrade costs about $600.

Hardware

ADAM comes with 80K of RAM, which can be expanded to 144K. This is more memory than any other home computer offers, including PC*jr*. The machine uses the Zilog Z-80 micro-

Pictured is the ADAM™ *Home Computer System. (Photo courtesy of Coleco Industries, Inc.)*

processor. In the upgrade version, ADAM uses the CPU located in the ColecoVision unit.

ADAM features a typewriter-style keyboard with full-travel keys (as opposed to a membrane or rubber dome keyboard) and six special-function keys. The truly amazing thing about the ADAM is that its price includes a letter-quality printer, a high-speed tape drive, and word-processing software.

The printer sold with ADAM uses technology licensed from Brother (a manufacturer of low-cost printers) by Coleco. As you might expect, the printer is somewhat limited, especially in terms of print speed. The ADAM printer has a top speed of 120 words per minute, or roughly 12 characters per second, about the same rate as a highly skilled human typist. Still, this printer is an amazing offer. When the authors first became involved with micros, letter-quality printers sold for $3,000 to $4,000. The implicit price of the ADAM printer is about $150.

The high-speed tape drive is both an advantage and a weakness. Because ADAM has used this special kind of tape drive, which is

faster and more reliable than a cassette tape drive, ADAM has fairly advanced file storage capabilities at an extremely low price. The unit also offers the CP/M operating system, customized by Coleco for use with a tape drive. If (and this is a big if) software publishers decide to convert their software to run on ADAM's tape drive, the computer will have the advantage of the thousands of CP/M programs already on the market.

The tape drive, however, is not nearly as useful as a disk drive. Coleco selected the tape drive to help keep the cost low, but the company probably would have been better off raising the price by approximately $100 and adding a disk. Coleco has promised that a disk drive will be introduced for ADAM soon.

Software

The basic ADAM unit includes three pieces of software: Smart BASIC, SmartWriter, and a Super Game Pack. Smart BASIC was designed to be source-code compatible with Applesoft BASIC, a very popular BASIC dialect sold with the Apple II. The game pack features high-resolution color games on cartridge. These games are essentially improved ColecoVision games that plug into the main ColecoVision unit.

Coleco hopes that SmartWriter will be ADAM's ace. With SmartWriter and the standard printer, the ADAM is by far the world's lowest-cost word processor. Because Coleco has shipped only a few units so far, we have not been able to review this program. Early rumors cast some doubts on its capabilities, however. One serious limitation for SmartWriter is the ADAM's video display. The ADAM can display only 32 text characters per line. As we have seen, displays of 40 characters or less are not great for word processing.

Other programs on the way for ADAM are personal management programs like Smart Filer and an electronic spreadsheet (perhaps Multiplan). Naturally, all ColecoVision cartridges will run on ADAM.

The ADAM is one of the few home computers that is not sold unbundled. The $600 price of the Coleco ADAM computer includes all the needed hardware, quite a bit of software

(including a word processor), and a letter-quality printer. We hope other manufacturers (including IBM) will adopt this strategy.

Unfortunately, ADAM was delayed several times before it was finally shipped. In fact, for a while it looked like Coleco and IBM were in a race to see who could wait the longest to introduce its new computer. Even before any substantial number of units were shipped, Coleco had raised ADAM's system price from $600 to around $750.

ADAM is probably the closest machine to PC*jr* in terms of price and capability. If SmartWriter turns out to be an acceptable word processor, and if Coleco follows through with its promise of more software for the machine, ADAM is likely to be a hit. There is no other home computer available today that offers more power and flexibility at such a low price.

If you already own a ColecoVision, ADAM may be the perfect way to get into full-feature computing. Other than price, the major difference between ADAM and PC*jr* is compatibility. PC*jr* is definitely compatible with the IBM PC; ADAM may or may not be able to use the CP/M library market.

Another important difference between ADAM and PC*jr* is found in the mass storage each uses. PC*jr* uses a conventional floppy disk drive. ADAM uses a new kind of streamer tape. If Coleco introduces a disk drive for the ADAM, this difference will be eliminated, but Coleco may never offer one.

The choice between PC*jr* and ADAM really is a software choice. If you prefer the programs offered by either machine, buy that machine. But be careful—betting on future software for ADAM may be a long shot.

Tandy/Radio Shack

The traditional microcomputer manufacturers are also active in the home computer market. Tandy/Radio Shack offers several computers that can be used in the home, from the Color Computer to the TRS Models III and IV.

Introduced in 1980, the Color Computer was one of the first "computer in a keyboard" designs. This style has been emulated by Commodore in its VIC-20 and 64 and by the Atari XL computers. The Color Computer is another of the "mainly games" class of home computers. The machine offers a wide range of game cartridges that take advantage of the computer's excellent graphics capabilities. A very popular BASIC dialect is also included with the unit.

The Color Computer is a good basic home system. The unit offers 16K of RAM (expandable to 32K) and 8K of ROM, which, as usual, stores the BASIC programming language. An advanced version of BASIC, Extended Color BASIC, is sold on an 8K ROM cartridge.

Radio Shack offers a disk drive for the color computer. The drive has a 156K capacity and sells for $599. About the only use for the drive, though, is for storing your own programs and data. Almost none of the machine's software supports the drive. Tandy also offers printers and modems for the Color Computer.

Because it has been around so long and has become so popular, the Color Computer offers a large software library. Although the library includes several personal management programs, the bulk of the Color Computer's software is for education or entertainment.

The Color Computer matches the Commodore VIC-20 closely in price and capabilities. If you are looking for a good, simple home computer, either machine may be for you. Remember, however, that the Color Computer, like the VIC-20, offers only limited memory expansion, and you can buy other more powerful computers for nearly the same price.

Another home computer from Radio Shack is the Model I. The TRS-80 Model I was one of the first home computers. It offered no color, no disk drive (at first), and only a limited amount of software. The Model I was a transitional computer; although it was shipped assembled, it was really a "home brew" computer. Many models ended up in the hands of computer hobbyists, who have created large libraries of "do it yourself" software for the computer. Though the Model I enjoyed terrific success, it was replaced by the Model III in 1980 and is no longer available.

The TRS Model III is a transplant computer, intended to be used primarily in the office but frequently used in homes. Just three years ago, the Model III was a state-of-the-art microcomputer. It offered standard 16K of RAM, expandable to 48K, and Model III BASIC in 14K of ROM. The machine used a (then) high-powered microprocessor, the Zilog Z-80. You could buy diskette drives for the computer, and it was supported by a large library of software.

The Model III has some disadvantages as a home computer, however. Virtually no graphics capability limits its usefulness as an entertainment or educational system. Because it can produce only a 64-character display line, the machine is limited as a word processor.

TRS-80 Model IIIs are used at home for programming and personal management. Because most home computers offer these applications, plus entertainment and educational programs, the TRS model is probably not a good choice for a home computer, especially as the price of the machine is $999 stripped, and over $1300 in a typical configuration.

Transplants

The last group of home computers are the transplants. This group, which includes the Apple II and the IBM PC, were not designed for use in the home but are among the most popular home computers.

The Apple II

The best-selling computer of all time, the Apple II, is also one of the most popular home computers. The Apple II (and its offspring the Apple II+ and Apple IIe) really defined the full-feature computer. Some observers have likened the Apple to the Model T Ford.

The history of Apple is almost a history of the personal computer industry. Across its six-year life, the Apple II has accumulated an impressive string of firsts. The II was the first home computer to be sold fully assembled rather than in kit form. The Apple II was also the first fully programmable computer of its size. Apple was

The Apple IIe (Photo courtesy of Apple Computer, Inc.)

also the first 64K home computer and the first one to offer a low-cost floppy disk drive and a fairly sophisticated operating system. In the early days of the industry (as far back as as 1977!), the Apple II was the only full-feature computer to offer color graphics and a disk drive. These firsts combined to make the II incredibly popular.

Apple also pioneered the concept of expandability. The Apple offers eight expansion slots that can be used for everything from adding more memory to the computer to attaching the Apple to a laboratory machine. The founders of Apple, Steve Wozniak and Steven Jobs, decided to make the Apple an "open system," a decision that had great impact on the computer's success.

Another important advantage of the Apple II is its software library. Almost every program that will run on PC*jr* has a version for the Apple II, and there are hundreds, perhaps thousands, of other programs for this computer. The library includes some types of software that are not currently available for PC*jr*, like accounting and sophisticated data management.

The Apple IIe

The IIe, which is the latest enhancement of the Apple II, corrects some of the flaws of the early IIs. Apple has introduced the IIe to compete against the IBM PC and other popular computers while its next family of computers is being developed. The basic Apple IIe uses a Mostek 6502 microprocessor and offers 64K of RAM; an additional 64K of RAM can be added. The popular Applesoft BASIC language on ROM is an integral part of the machine. The increased memory makes the II more competitive with the IBM PC (and PC*jr*) for high-memory usage applications like electronic spreadsheeting.

The II and IIe look about the same except that the keyboard on the IIe has a couple of extra keys. The IIe has superior video display characteristics. With an optional expansion card, the IIe uses both upper- and lower-case letters in the video display and can display 80 characters per line. The Apple II used only upper-case letters and had a 40-character line that caused some difficulties for word processing on the Apple.

Apple is also working to develop new applications for the IIe. One is Apple Writer II, a low-cost high-powered word processor and one of the most popular programs currently on the market for any computer.

The Apple II and IIe continue to sell well today. In fact, the Apple II may be the most significant competition for PC*jr*. One advantage of the Apple is its tremendous library of software. Far more home and entertainment software is available for the Apple than for any other machine. The Apple IIe also offers hardware power similar to PC*jr*'s.

The only major disadvantage of the Apple is that it is not compatible with a more powerful desktop computer. Unlike

PC*jr*, which can use much of the software developed for the IBM PC, the Apple has no bigger brother to look to for extra software. Because the Apple II's library is so large, this won't be a major problem at first. But as PC*jr* raises the stakes in the home computer software game, Apple will feel the pressure.

The IBM PC

Although the IBM PC is designed to be a business computer, many people have purchased IBM PCs for home use. Home management, education, and entertainment programs have been released for the PC. To the extent that the PC is used as a home computer, PC and PC*jr* are competitors. Let's compare the two machines carefully.

PC*jr* is in many ways similar to its older brother, the IBM Personal Computer. Like the PC, the PC*jr* uses a 16-bit Intel 8088 microprocessor. The advanced version of the PC*jr* also uses the same disk operating system as PC DOS 2.1. Although PC*jr* uses a different type of disk drive, the diskettes used by the two machines are identical. Diskettes created by either computer can be transferred directly into the other.

The version of the BASIC programming language provided with PC*jr* is similar to that sold with the PC. The main difference between the two is that PC*jr* BASIC is sold on a plug-in cartridge, whereas IBM PC BASIC is sold on a diskette. PC*jr* BASIC also includes a few commands that have not previously been available for the IBM PC.

Because the PC*jr* and the PC use BASIC, DOS, and the same microprocessor, they can use much of the same software. Some of the first programs available for PC*jr*, including Time Manager, pfs:FILE, pfs:REPORT, and EasyWriter, are adaptations of programs that were first developed for the PC. Other software that runs on the IBM PC, like WordStar, VisiDex, and Microsoft Flight Simulator, should be easy to adapt to the PC.

PC*jr* or IBM PC?

An IBM PC with the same basic capabilities as a PC*jr* is far more expensive. The following table shows the comparative cost of an

IBM PC system configured as much like the enhanced model
PC*jr* as possible.

Table 10.1
Comparative Cost of the IBM PC

IBM PC System Unit 64K with 360K Diskette	$ 2,104
IBM 64K Memory Module Kit	165
PC DOS 2.0	60
IBM Color Graphics Monitor Adapter	244
Sup 'R' Mod RF Modulator	70
Printer Adapter	150
IBM PC Compact Printer	175
IBM PC Compact Printer Connecter Adapter	40
Assorted Software (matches cost of software bought for PC*jr* in Chapter 9)	470
	$ 3,478

This total price is more than $1,300 higher than the price of a PC*jr*
with about the same capability. Because PC*jr* offers many of the
hardware features found on the IBM PC (and some extras) and
because much of the software that runs on the IBM PC will also
run on the PC*jr*, the younger brother may seem like a better buy
than the IBM PC.

In some ways, PC*jr* is a better buy than the IBM PC. The PC*jr* is
an extremely powerful home computer. It offers more power than
the business computers of a few years ago, and in some cases can
be used for business applications. But the PC*jr* also has some
serious limitations as a business machine.

PC*jr*'s Limitations

There are some important differences between PC*jr* and the IBM
PC. First, the PC*jr* cannot be expanded as much as the PC. For
example, the IBM PC can be expanded to contain as much as
512K of RAM. Officially, PCJr can be expanded to only 128K.
An IBM PC can be expanded to 10 megabytes or more of disk
storage. PC*jr*, on the other hand, can accommodate only 360K of
disk storage in its standard configuration.

Both of these limitations on the PC*jr* are significant. Because the machine can access only 128K of RAM, some of the newer programs designed for the IBM PC will not run on the PC*jr*. These programs include Lotus 1-2-3 and Context MBA, both of which require more than 128K of memory just for the program. The disk storage limitation is significant in the area of accounting and data base management. The accounting records for even a small business can easily expand to fill and overflow a 360K floppy disk, such as those provided with the PC*jr*.

In part because of these limitations, little business software is available for PC*jr*. At this time PC*jr* has no accounting software of any kind, and many other important business programs, including 1-2-3 and dBase II, are not available on PC*jr*. Although this situation is almost certain to change, the current lack of these programs makes it hard to recommend the PC*jr* as a business machine.

The keys on the PC*jr* keyboard are significantly different from those on the PC. The IBM PC keyboard has 83 keys; the PC*jr* has only 62. PC*jr* has only 5 special-function keys and no numeric keyboard. Because PC*jr*'s keyboard offers fewer keys, some software for the IBM PC may not run on PC*jr* without modification.

Which One to Buy

If you plan to use your new computer in business, you are probably better off with the original IBM PC. The PC is much more expandable than PC*jr*—640K of RAM contrasted with 128K. Although this difference doesn't matter for home applications, in business use the larger RAM size of the PC can be important.

The PC can accommodate up to 20 megabytes of hard disk storage. At present, PC*jr* offers only a single 360K floppy disk drive. It seems likely that PC*jr*'s disk storage will be expanded, but until that occurs, PC*jr*'s disk storage is inadequate for accounting and heavy-duty data management.

Another important difference between IBM PC and PC*jr* is software. Much of the software currently available for the PC will

soon be available for PC*jr*. Still, many important business programs, like 1-2-3 and Context MBA, will probably never run on PC*jr*. Others that are translated (including some programs already available for PC*jr*, like Multiplan and VisiCalc), will be limited by PC*jr*'s smaller RAM size.

If, on the other hand, you are in the market for a sophisticated home computer, PC*jr* may be perfect for you. PC*jr* offers a combination of features never before available in a home computer.

Just as PC*jr* will not use some PC software, some PC*jr* software will not be usable on the PC. For example, many entertainment and educational programs available for PC*jr* will be delivered on ROM cartridge. Because the IBM PC does not have program cartridge slots, these programs will not be usable on the IBM PC. If you are primarily in the market for an entertainment system, PC*jr* will probably be the best choice.

As we have seen, PC*jr* is a relatively expensive home computer. A typical PC*jr* system will cost between $1,500 and $2,200. Still, PC*jr* is less expensive than an IBM PC. A PC equipped like the "typical" PC*jr* system designed in Chapter 2, would cost nearly $3,500. The extra $1,500 buys expandability. Our $2,000 PC*jr* is near its upper limit of RAM and disk capacity, whereas the PC is only lightly loaded. If you don't need the expandability, it simply doesn't make sense to spend the money.

Who Will Be Hurt by PC*jr*?

No doubt the biggest impact of PC*jr* will be on those computer manufacturers, such as Zenith, Vector Graphics, and Morrow, that make 8-bit desktop computers. These machines, the cream of the crop a few years ago, now seem sadly underpowered and overpriced. PC*jr* offers more capability and flexibility than any of these 8-bit machines—at half the price. Individuals and businesses who want a medium-capability machine at a good price will almost certainly select PC*jr* over these older machines.

The Apple II, the most popular microcomputer for the last six years and the best-selling computer ever, will almost certainly start to decline because of PC*jr*. Many analysts expect Apple to

Table 10.2
Popular Home Computers Compared

Model	Base Price[1-2]	CPU (bits)	RAM Capacity Min	RAM Capacity Max	Best Video Display Text	Best Video Display Graphics	Cartridge	Storage Disk Drive	Drive Capacity
Apple IIe	$1395	MOS 6502 (8)	64K	128K	80X24[5]	280X192	N	Y	140K
Atari 600XL	$ 249[6]	MOS 6502 (8)	16K	64K	40X24	320X192	Y	Y	127K
Atari 800XL	$ 399[6]	MOS 6502 (8)	64K	64K	40X24	320X192	Y	Y	127K
Coleco ADAM	$ 750[4]	Zilog Z80 (8)	80K	144K	32X24	280X192	Y	N[3]	N/A
Commodore VIC-20	$ 99[8]	MOS 6502 (8)	5K	32K	22X23	176X184	Y	Y	170K
Commodore 64	$ 219[6-8]	MOS 6510 (8)	64K	64K	40X24	320X200	Y	Y	170K
IBM PC*jr*	$ 669	Intel 8088 (16)	64K	128K	80X24[5]	320X200	Y	Y	360K
IBM PC	$1540	Intel 8088 (16)	64K	640K	80X24	320X200	N	Y	360K
Tandy Color Computer	$ 239[7]	MC 68009 (8)	16K	32K	32X16	256X192	Y	Y	156K
TI-99/4A	$ 100	TMS9900 (16)	16K	32K	32X24	192X256	Y	Y	70K

[1] Base price is provided for rough comparison only. Equipment included in base price varies widely among computers in the table. Some computers, including PC*jr*, require optional hardware and software to be useful.

[2] Prices are based on telephone research conducted on November 17, 1983. Prices are subject to sudden changes.

[3] ADAM uses a high-speed digital tape drive instead of a disk drive. Tape has a capacity of 256K. Tape drive included in base price.

[4] Base price includes tape drive, letter-quality printer, and word-processing software. Approximate retail price is based on recent Coleco dealer price increase.

[5] Requires optional display enhancement

[6] Includes RF modulator

[7] Frequently on sale for as little as $159

[8] Mail order price

introduce a low-cost version of the Apple II to compete against PC*jr*. A new Apple version will probably offer a single disk drive, an RF modulator (for connecting the machine to a TV set) and 64K of RAM, for under $1,000. If Apple designs such a computer, the competition between IBM and Apple should be interesting.

Apple is also expected to announce its new computer, MacIntosh, early next year. MacIntosh is supposed to incorporate much of the exciting software technology found in Apple's Lisa at a price rumored to be as low as $2,000. Those who have seen MacIntosh have given glowing reviews of the machine. "Mac" will no doubt be worthy competition for PC*jr*.

Another group sure to feel the crunch from PC*jr* is the other home computer manufacturers. In fact, the effects of PC*jr* were felt long before the formal introduction of the computer. Stock prices of all the major home computer manufacturers fell sharply in the months just before PC*jr* was introduced. Coleco's stock fell from over $60 per share to about $20 per share. Texas Instruments stock declined substantially, then climbed after the news that TI was getting out of the home computer market! Atari and Mattel also experienced big stock price drops.

Probably the only company that is benefiting from the confusion in the home computer marketplace, at least in the short run, is Commodore. Commodore's 64 is directly competitive with the PC*jr* but sells for far less. Commodore has also benefited from Texas Instrument's departure from the market and from Coleco's delays in shipping ADAM.

Commodore has already announced a 128K version of the 64. This computer, the Commodore 128, is likely to provide major competition for PC*jr*. The success of Commodore depends on the company's ability both to improve the quality of its units and to make a profit even at extremely low prices.

Many potential ADAM buyers will desert Coleco for Commodore and PC*jr*, unless Coleco can begin shipping ADAM in volume. In fact, there is some chance the Coleco is already in big trouble with ADAM. For one thing, the price of the Coleco system was raised even though it has never been shipped in volume. In addition, although Coleco claims it began shipping

units in early November, 1983, very few have actually been delivered. Missing the Christmas season could be the end of ADAM.

Nearly every other company in the industry will gain as a result of the high prices IBM is charging for PC*jr*. PC*jr*'s base price is two or three times higher than the base price of competitive machines. This large gap should give the other home computer manufacturers some room to breathe. In fact, there will probably be other price increases in the home computer market before long.

The Big Winner

The only conclusion that can be drawn from all of this is that the PC*jr* competes against a wide variety of computers and game systems. These machines are virtually impossible to divide into classes by price, capabilities, or anything else. For example, the Atari 5200, a game machine, costs $199.99, while the Commodore 64, a powerful computer, can be acquired for as little as $219.

PC*jr* really defines a new class of computers: the home productivity computer. It offers power that just a few years ago was reserved for business computers, but has enough flexibility and a low enough price to be an attractive home computer.

Only the Coleco ADAM and the Commodore 64 come close to PC*jr* in terms of price, and they lack the all-important characteristic of compatibility with the IBM PC. Although it is too early to eliminate these competitors from the race, PC*jr* is very likely to outsell both machines substantially.

The main competition for PC*jr* is likely to be the IBM PC. These two machines are similar in so many ways that many consumers will be confused about which machine is better for them. PC*jr* has some limitations that make it unsuitable for some of the heavier applications, but at the same time, PC*jr* has capabilities that PC cannot match. The key to deciding between the two machines is a careful evaluation of your own needs.

No matter what impact PC*jr* has on other home computers, one thing is virtually assured: PC*jr* will be a winner. In PC*jr*, IBM has

introduced a machine that competes effectively with a wide range of home computers. They have assured a large software library for PC*jr* by making it compatible with the IBM PC. PC*jr* has the features needed to be successful in home computing.

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The Future:
Expanding PC*jr*

IBM has clearly designed PC*jr* to be a "complete" computer. The company is already offering, at very attractive prices, nearly every popular expansion device: memory expansion, a parallel port, a serial port (included with the basic unit), a modem, a low-cost printer, a color monitor, joysticks, light pen adapters, a cassette port, and even a carrying case. About the only item missing is a clock. Still, there is no doubt that PC*jr* owners will demand "more" for their machines—more memory, disk storage, and software. PC*jr* will likely follow the pattern established by other popular computers, including the IBM PC and the Apple II.

Expanding IBM PC

Almost immediately after the IBM PC was introduced in 1981, a wide range of expansion hardware devices began to emerge. The same thing occurred when the Apple II appeared in 1978. It is likely that this phenomenon will be repeated with PC*jr*.

The group of expansion options produced for the IBM PC includes advanced color cards, memory expansion boards, clocks, serial and parallel ports, and a variety of other items.

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Many manufacturers also produced "multifunction" boards that combined memory expansion, a clock, and serial and parallel ports on one card. A few companies developed hard disk storage devices for use with the IBM PC.

These manufacturers were successful for several reasons. First, they sold their products at much lower prices than those of comparable IBM "logo" products. Second, they offered options and combinations of options that were not available from IBM. Several of these companies, including Tecmar, AST Research, Davong, and Quadram, have been very successful.

Expanding PCjr

As you learned in Chapter 3, PC*jr* offers three main expansion connections. IBM designed these expansion slots for adding the 64K RAM and Display Option board, the Diskette Controller Card, and the IBM Internal Modem to PC*jr*. These connections are "dedicated," and according to IBM, only to be used for the purposes specified by the company. The expansion slots on the IBM PC, on the other hand, are "open," and can be used by almost any peripheral card. Because PC*jr*'s connections are dedicated, it is unlikely that they can be used for adding other, non-IBM expansion options unless those options imply mimic the functions of one of the three IBM devices. (Never underestimate the imagination of a computer whiz, however—even though IBM does not support any alteration of these slots, it is likely that some eager individual will find a way to use them.)

Fortunately, PC*jr* offers one other expansion connecter: the 60-pin I/O bus, in which the optional parallel port is attached to the system unit. This connector is very similar to the bus used by the IBM PC to connect the expansion chassis to the main computer. This bus may turn out to be the philosopher's stone of PC*jr* expandability. It is very likely that any hardware expansion for PC*jr* will use this bus, which contains all of the data lines necessary to add almost any expansion device to PC*jr*, including more memory, parallel and serial ports, and a hard disk.

What You Can Expect

The first option to be made available by outside manufacturers may be an expansion chassis that could hold several expansion devices. This chassis will connect to the PC*jr*'s 60-pin I/O bus. Expansion circuit boards will plug into slots located in the chassis; these slots will probably offer space for a disk drive or two and perhaps support even a hard disk. Because PC*jr*'s power supply is not sufficient to drive a large number of options (and especially not a hard disk), the chassis will likely include its own power supply.

Since the 60-pin bus is like that offered by the IBM PC, and because PC*jr* is so similar to the IBM PC, it is probable that, given the right expansion chassis, many of the expansion boards available for the IBM PC will be available to PC*jr*. If this probability is true, there is virtually no limit to the expandability of PC*jr*.

Because too much expansion of the computer would be a bad thing for IBM (overexpansion would cause PC*jr* to compete with the PC), we don't expect to see this sort of chassis from IBM. A possible candidate for the first such device is Tecmar, which already sells a similar chassis for the IBM PC.

Memory

Although IBM intends for PC*jr* to expand only to 128K of RAM, the machine can handle far more memory. The 8088 processor in PC*jr* can address as much as 1,048,000 bytes of memory at one time. Since PC*jr* has 64K of ROM on board, and the capacity for another 64K in cartridges, the maximum amount of RAM the computer can use is 896K. There may be an IBM-imposed limit that falls below this number. For example, the IBM PC, which uses the same microprocessor, has a limit of 640K RAM. Even if this limit applies to PC*jr*, there is still a great deal of room for expansion memory.

A recent issue of *PC* magazine included dozens of ads for memory expansion boards. Boards with 64K for the IBM PC were selling for as little as $295. (Most include sockets that allow expansion to 256K or more.) Compare this price to the $140 price of the IBM

Memory and Display Option card. Clearly, IBM's competitors are going to have a hard time beating the company's prices for PC*jr* expansion options. The likely strategy for memory board manufacturers will be to offer products that simply are unavailable from IBM, like 256K RAM boards, or boards that offer both memory and some other option like a parallel port.

Clocks

Another popular option for the IBM PC are clock cards, which contain an electronic clock and batteries. The latter allow the clock to keep time usually for up to eight days, even when the PC*jr* is turned off. For most users, a clock is a luxury. Very few applications require one. About the only advantage of an automatic clock is that you no longer have to enter the time and date every time you boot DOS. The clock automatically informs DOS of the proper time. Clocks for the IBM PC are almost always included with multifunction boards.

Communications Ports

Although IBM offers a serial port as standard equipment on PC*jr* and a parallel port as a $99 option, you can expect to see expansion boards for PC*jr* that offer these devices as well. For one reason, the serial port provided with PC*jr* uses a nonstandard connector. To use a printer (other than the Compact Printer) or a modem (other than the Hayes) on this port requires a special adapter. A standard-connector serial port is thus a logical expansion option. Since PC*jr* has only one serial port, you cannot use two serial devices—the Compact Printer and the Hayes modem, for example—with the machine at the same time. If you want to use two or more devices at once, two ports are necessary.

Since any expansion for PC*jr* will be done through the 60-pin I/O bus, it will be impossible to connect both the IBM parallel adapter and an expansion chassis to PC*jr*. This means that a non-IBM parallel port will be required for expanded units that need a parallel port.

IBM's parallel port for PC*jr* is a $99 option. Because many printers, including the IBM Graphics printer and the NEC 3550, require a parallel port, many PC*jr*s will be sold with them. Look

for a large number of manufacturers to offer such ports for PC*jr* at prices well below IBM's $99. Parallel ports are very compact and can be easily packaged with another option, including memory. A variety of multifunction boards that offers memory, a parallel port, a serial port, and perhaps even a clock on one board is possible.

Disk Drives

Another expansion option likely to emerge for the new computer is disk drives. IBM charges $480 for its PC*jr* disk drive and controller board. The basic drive used by IBM is manufactured by Qume™ Corporation and is available wholesale for about $200. This difference will simply be too attractive for third-party manufacturers to pass by.

Disk drive sets will be developed that can be used instead of, or in addition to, the PC*jr*'s own disk drive. Packages designed to be used in place of PC*jr*'s own drive will include a drive, a non-IBM controller card that fits in PC*jr*'s diskette controller adapter, and simple installation instructions. This set of products may soon be purchased to convert an entry PC*jr* to the enhanced model. Such substitute drive packages will probably be available for as little as $350.

Disk storage expansion packages will also be introduced for PC*jr*. Although IBM officially supports only one disk drive, the diskette controller chip used by PC*jr* can manage as many as four. DOS 2.1 can accommodate even more. Many programs available for PC*jr* that were originally designed for the IBM PC can use more than one drive. In fact, some programs require more than one.

Third-party manufacturers will undoubtedly introduce packages that supplement PC*jr*'s disk storage. All that would be required to add drives is a disk drive in a metal or plastic box and a special cable, which would "daisy chain" one or more external diskette drives with PC*jr*'s internal drive. Since PC*jr*'s power supply is relatively weak, these external drives might possibly require their own power supply, which could be accomplished by enclosing the power source with the drive or by packaging the drive in the expansion chassis. Since this package does not include a

controller, additional drives might be available for as little as $250.

Hard Disk

A hard disk, also called a rigid disk or a Winchester disk, is a high-capacity mass-storage device. As the name implies, hard disks are rigid, unlike floppy disks, which are flexible. Typically, a hard disk is also "fixed"; that is, it cannot be removed from its drive. Hard disks offer much higher storage capacities than floppies. The smallest Winchester disks offer five million bytes of storage—over ten times the capacity of a PC*jr* floppy. Hard disks are usually much faster than floppies. After using a floppy-based computer system, a hard disk system will seem superfast.

Can PC*jr* use a hard disk? As with many features of the computer, whether PC*jr* can use a hard disk is difficult to say at this point. DOS 2.1, PC*jr*'s operating system, is designed to be used with a hard disk.

However, a hard disk might make PC*jr* more powerful than IBM intends. For the same reason that IBM "officially" limited PC*jr*'s memory, it is unlikely that the company will introduce a hard disk for PC*jr*. Introducing such a disk would muddy the difference between PC*jr* and the IBM PC XT, IBM's high-end microcomputer. Still, PC*jr* has the hardware and operating system required to use a hard disk. If suitable expansion chassis are introduced, it will be only a matter of time before one of the third-party manufacturers come up with a hard disk for PC*jr*. Hard disks for the IBM PC range in price from about $1700 for a five-megabyte unit to over $2499 for larger ten-megabyte units, prices which probably won't change much on PC*jr*.

Networking

If IBM introduces a hard disk for PC*jr*, the disk will probably be part of a Local Area Network (LAN) system, which allows a large number of independent computers to share information and peripherals, like printers and hard disks. LANs are becoming very popular with big companies and schools because they permit a large number of computers to communicate easily. Because of PC*jr*'s low price and high capability, some networkers, especially

schools, may see the computer as an ideal network-node computer.

A Word of Caution

One word of caution is needed: IBM does not currently back the expansion of PC*jr* through the 60-pin bus. The company is supporting no more than one disk drive, with 128K of RAM. By "limiting" PC*jr* in this way, IBM has built a strong hardware boundary between PC*jr* and the IBM PC. If you want more than 128K of RAM, more than one disk drive, or a hard disk, you need PC. This strategy protects IBM's lucrative PC market from erosion by "super-expanded" PC*jr*s. Although it seems unlikely, it is possible that IBM has permanently restricted the expandability of PC*jr*. If this is true, much of what we've just been talking about will never happen.

The authors don't believe that IBM has made PC*jr* virtually unexpandable. The "freedom to expand" is included in article I of the computer user's Bill of Rights, drafted by Steve Wozniak of Apple, years ago, and ratified by IBM, with its flexible IBM PC. Making PC*jr* unexpandable would be a terrible marketing mistake, and IBM doesn't make marketing mistakes. More likely, IBM is simply not going to support any further options but will allow other companies to enhance PC*jr*.

No matter what IBM says, PC*jr* users will clamor for "more" for their computers. These users will insist on having more memory, more disk storage, and other expansion option for their machines. If IBM does not fill this need, other manufacturers will.

Is Expansion Worthwhile?

Although it is always comforting to know that your computer is upwardly mobile, it would be a mistake to buy a PC*jr* if you already know that you want to add a hard disk, 512K of RAM, a raft of high-powered software, and other expensive options to the machine. For one thing, there is no guarantee that such options will be available. Even if they do become available, you will have to wait at least several months at least before you will be able to buy one of these options. Buying PC*jr* now with the thought of

adding a lot of options that haven't even been introduced yet is asking for trouble.

If you want all of the power offered by a hard disk and high RAM memory, you will be much better off buying a PC or PC XT. IBM supports—in fact, encourages—the expansion of these machines. And when all is said and done, you're likely to spend less on the IBM PC or XT than on a comparably equipped PC*jr*.

Software

Even if the expansion of PC*jr*'s hardware is in doubt, the availability of more software for the computer is assured. First, IBM has made PC*jr* nearly compatible with the IBM PC. Therefore, large amounts of existing software will need only be converted or adapted in some small way to function on PC*jr*. Second, PC*jr* uses a variant of the popular MicroSoft BASIC language. Consequently, loads of software written in this language for other computers can be translated to run on PC*jr* with minimal effort. Third, IBM is continuing to encourage the development of new third-party software for both the IBM PC and PC*jr*. A large library of software for the PC*jr* will likely develop across the next few months.

Software from Other Computers

New PC*jr* software will come from several sources. First, a great deal of today's popular entertainment software will probably be converted to run on PC*jr*. Programs originally developed for the Atari, Commodore, Coleco, and TI will be translated. Games developed by independent software houses, like Thorn EMI™ and Activision™, will be among the first to be converted, and it is likely that the other home computer manufacturers also will convert at least some of their software to run on the PC*jr*. Before long, you should be able to play PacMan™, Turbo™, and River Race™ on your PC*jr*.

Cartridges for Other Home Computers

A less certain possibility is that someone will develop an adapter to allow PC*jr* to accept game cartridges developed for other home computers like the Atari 5200, the TI 99/4A, and the Coleco-

Vision. The owners of PC*jr*s (who will get a new library of popular programs for their machines), the owners of the other home computers (who will be able to use their old software after they move up to PC*jr*), and the manufacturers of the other home computers (who are hoping to sell large volumes of their software) will benefit.

Before you get your hopes up too much, we should warn you that developing such an adapter can be a terribly difficult process. For a variety of reasons, the adapter almost certainly cannot work through PC*jr*'s cartridge slots but will have to communicate with PC*jr* through the 60-pin bus described earlier. Therefore, the adapter will probably be too expensive and cumbersome for most users, and most cartridge publishers will likely choose to translate their popular programs to run on PC*jr* without an adapter.

Apple II Software

The Apple II offers the largest software library available for any computer. Although the Apple II software family includes programs for all kinds of computing, the entertainment and educational software will be most important to PC*jr*. The list of Apple II game publishers goes on and on. Datasoft™, Muse™, Artworx™, Thorn EMI, Broderbund™, and many others have created successful businesses by selling games for the Apple.

As many Apple II users exchange their old machines for PC*jr*s, the demand for the popular Apple programs for PC*jr* will rise; new PC*jr* owners will want to continue playing their favorite Apple games.

Numerous entertainment programs available for the Apple II will be translated. Since PC*jr* uses a different version of BASIC, a different microprocessor, and a different operating system than the Apple II, the Apple-to-PC*jr* conversion will probably take longer than some others.

IBM PC Software

The chart in Chapter 9 shows which IBM logo software products will run on PC*jr* and what is required to make them run. The IBM logo library is only a small part of the overall IBM PC software family. What about the rest of these programs?

Since the PC*jr* is in many ways so similar to the PC, much of the software already available for the IBM PC will run on the PC*jr*. There is, however, no guarantee that the specific program you want to use on PC*jr* will be available. In fact, Murphy's law would seem to indicate just the opposite.

Many of the programs that cannot be merely transported to the PC*jr* will be translated. Among the first will be the entertainment and educational software that runs on the PC. One program almost certain to be converted is Microsoft's Flight Simulator, a very popular game for the IBM PC. Other IBM PC entertainment software is likely to follow, together with, for example, the adventure games from Infocom—the Zork™ family, Deadline, and others. The popular arcade games from Datamost and the strategic games from Strategic Simulations™ will also be available on PC*jr*. Sierra On-line, the original publisher of several of PC*jr*'s programs (such as HomeWord and Crossfire) will transfer some of its other games, like Frogger.

Most of the word-processing programs that run on the IBM PC should be easy to transport to PC*jr*. They do not demand as much disk or RAM capacity as 1-2-3 and dBase II. Since HomeWord and Easywriter are not as popular as some other word processors, including WordStar, Microsoft Word, and MultiMate™, the market will demand these other programs on PC*jr*. Another word processor likely to be available for PC*jr* is pfs:WRITE, a companion to pfs:FILE and pfs:REPORT, two of PC*jr*'s data management programs. Expect quite a race among these manufacturers to be the first non-IBM word processor.

SuperCalc™, another popular electronic spreadsheet, is also likely to be converted. Sorcim™ Corporation, publishers of SuperCalc, has always been agressive in putting its product on as many computers as possible. Since SuperCalc already is available for the PC, the conversion process should be fairly simple.

Many of the popular personal data management programs for the IBM PC will be available for PC*jr*. This group includes VisiFile™, VersaForm™, and EasyFiler™, which will compete against IBM's pfs:REPORT and pfs:FILE for a share of the home data management market. Another popular IBM PC data manage-

ment program, dBase II™, will probably also be converted. However, serious dBase applications require a great deal of disk storage capacity; until PC*jr*'s storage capacity is expanded, therefore, dBase will be limited.

Programs Not Likely to Be Translated

Some IBM PC programs that require more RAM memory or disk capacity than the PC*jr* offers will probably never be converted. IBM PC's popular super-spreadsheet, Lotus™ 1-2-3™, for example, requires over 128K of RAM just for the program. Context MBA, another integrated spreadsheet program, requires 256K of RAM for the program alone. 1-2-3 and MBA could be used on PC*jr* only if the machine's RAM can be expanded beyond the IBM limitations or if Lotus decides to distribute the program on a cartridge.

The difference between keyboards on the two machines is another reason some programs will not be converted to PC*jr*. As we saw in Chapter 3, the PC*jr* has only 63 keys, compared to the IBM PC's 82. Some programs that use every key on the IBM PC keyboard, like 1-2-3, may not be able to work on the more restricted PC*jr* model.

The accounting programs will not be immediately converted. This group, which includes the BPI and Peachtree families, simply demands too much disk storage capacity to be used effectively on a PC*jr*. However, if the computer's basic storage capacity is expanded at some point, either by IBM or by outsiders, these programs may be converted.

Unlike the business accounting programs, the home accounting systems like Home Accountant, Financier II, and PC/PFP, are sure to be rapidly converted to PC*jr*. These programs will compete heavily with Home Budget, *jr*, PC*jr*'s only home financial management program.

Tax-planning programs will follow the home accounting variety. Such programs—for example, MicroTax™, and HowardSoft™— will not be available for use in planning or preparing 1983 returns,

but will undoubtedly be among the most popular for PC*jr* next Christmas.

Educational Software

The educational software market for the IBM PC is just beginning to open up. Because it is a relatively expensive computer, many educational publishers have delayed introducing their products. Those who have not waited are going to have a real head start. One leading publisher of IBM PC educational software is CBS Software, which publishes educational programs, like Mastering SAT and Success with Math, for a wide range of age groups and interests. Another publisher is Control Data Corporation. Its Plato line of educational software and games is rapidly gaining acceptance.

The educational software marketplace is quickly becoming filled with familiar names. A Xerox subsidiary is publishing the Weekly Reader™ Family Software line. MSA, the world's largest independent software house, has launched a series of educational programs called Eduware™. Milton Bradley™, long a leading board-game publisher, is beginning to publish educational programs. Reader's Digest is also entering the market.

New Software

Before too long, some all-new software will begin to emerge for PC*jr*. Since developing a new program takes longer than converting an old one (in most cases), these new programs will not be available right away. They should be very exciting because they will be the first to take advantage of PC*jr*'s special capabilities, like multivoice sound.

New programs will include offerings for all of PC*jr*'s markets: entertainment, education, and personal management. At first, publishers will move to fill perceived holes in IBM's software. For example, there is no cookbook program available today for PC*jr*, so it is likely that one will be developed. Later, publishers will challenge IBM's own programs like HomeWord and Multiplan.

Much of this new software will be educational, but there will be many home-management and entertainment programs as well.

Every wise publisher of educational programs will convert its software to run on PC*jr*. Likely sources of educational programs are publishers like Spinnaker and Scarborough.

The PC*jr* software marketplace will grow so fast that many new software publishers will emerge in 1984. Some will make their first contributions to PC*jr*. In fact, the machine's advanced capabilities will give software publishers the opportunity to develop startling new applications. PC*jr* is likely to set a new standard in the world of home computing.

New Operating Systems

IBM offers three operating systems—PC DOS, CP/M-86, and the UCSD p-System®—for the IBM PC, but only one of these, PC DOS, for PC*jr*. It is likely that IBM will offer one or both of the other systems for PC*jr*. Both offer a large library of applications software. In fact, CP/M offers the world's largest library of business software.

Surprisingly, Digital Research, Inc. (DRI), publishers of CP/M, and IBM have never had a particularly good relationship. IBM approached DRI early in the development stages of the IBM PC with the intention of making CP/M the PC's operating system. These talks broke down, and Microsoft's MS-DOS got the nod. Although IBM eventually offered CP/M for the PC, the operating system runs a distant second to PC DOS.

Even if IBM doesn't offer CP/M for PC*jr*, DRI will. DRI takes great pride in supporting the software publishers who sell software for the CP/M operating system. PC*jr* is too great an opportunity for DRI to pass by.

DRI is likely to make at least part of its family of languages available for PC*jr*. The DRI library includes a very good CBASIC Compiler, a C compiler, and DR LOGO™. The availability of these languages will broaden the programming alternatives available to PC*jr* users.

Books and Magazines

The IBM PC has also created a huge market for books and magazines about the machine and its software. At last count,

there were over ten monthly magazines about the IBM PC. Over fifty books on the computer have been published.

PC*jr* will probably generate a similar demand for knowledge. This is the first book available about PC*jr*, but dozens more will likely follow. Several magazines will no doubt begin to emerge for the PC*jr*. Some will come from the large publishing houses, like Ziff Davis, publishers of *PC* magazine, which has already announced *PCJR*, the magazne for PC*jr*s. Newcomers, hoping to catch a piece of the action, will publish other magazines.

Que Corporation will be a leader in the printed word about PC*jr*. This present book will soon be followed by *IBM PCjr Favorite Programs Explained,* by Don Kreutner, which is a collection of thoroughly explained BASIC programs for the PC*jr*. Kreutner's book will help you learn about PC*jr*'s BASIC.

Que is also introducing a new monthly magazine, the *IBM PC Update,* which will make you aware of the latest new hardware, software, and services available for the computer. *IBM PC Update* will also review dozens of computer and general interest magazines each month and will abstract and index articles about the PC and PC*jr*.

Will PC*jr* *Become a New Standard?*

Within eighteen months of its introduction, the IBM PC had become the industry standard for desktop computers. Almost every new desktop machine being introduced today is based on either the 8088 or the 8086 microprocessor made popular by the IBM PC. The generic form of the PC's operating system, MS-DOS, is the new standard. Programs originally developed for the PC, like 1-2-3, are now almost required for any successful computer.

Most observers expect PC*jr* to have a similar effect on the home computer market. PC*jr* will probably standardize the use of 16-bit chips and MS-/PC DOS in home computers. Also, future machines will probably use the same program cartridge configuration developed by IBM. This will help to assure program compatibility between PC*jr* and other machines.

PC*jr* look-alikes, or "clones," should begin to emerge almost immediately. Some will be developed by companies that already sell IBM PC-compatible machines, like Columbia systems, Compaq, and Corona. Others may be developed by companies already in the home computer industry.

Two likely candidates to introduce PC*jr* look-alikes are Commodore and Franklin. Commodore may attempt to jump the gun on PC*jr* by introducing a PC*jr*-compatible machine early next year at a price well below that of the original. Franklin has built a business around a computer that copies the Apple II exactly. These companies may see PC*jr* as the next great opportunity.

Other computer manufacturers already on the market will likely take steps to make their systems at least partially compatible with PC*jr*. Look for adapters that will allow machines like the Coleco ADAM, Commodore 64, and Atari XL line to run PC*jr* software.

Will IBM Change the PCjr?

Just prior to PC*jr*'s introduction, a very popular rumor emerged. Apparently, IBM originally intended to use a new microprocessor, the Intel 80188, in the PC*jr*. The 80188 is very much like the 8088 except that the 80188 integrates even more circuitry on a single chip. Thus, the 80188 requires fewer supporting chips, and a computer that uses the 80188 will be cheaper to build than one that uses the 8088. According to the rumor, IBM acquired thousands of 80188s from its subsidiary, Intel Corporation, for use in the PC*jr*, only to find that the 80188 is not quite fully compatible with PC DOS.

In the design of MS-DOS for the 8088, Microsoft apparently made some assumptions that made the system incompatible with the 80188. When IBM discovered the problem, they were faced with a decision: scrap the PC*jr* altogether, wait for the 80188 chips to be reworked and thereby delay the project for months, or change the design of PC*jr* to use the 8088 chip. This choice was a tough one. IBM sent all of the 80188s back to Intel, redesigned the PC*jr*, and delayed the announcement of the product by two months and the shipping date by over four.

If these assumptions are true, the logical question is this: will IBM at some point go back to using the 80188? If so, will a drop in PC*jr*'s price ensue? IBM keeps secrets so well that nobody will know the answers until a change is formally announced. If such a change does occur, it will probably be no earlier than late 1984.

Price Drops

As we noted in Chapter 10, the PC*jr* is more expensive than most of its competitors. This price difference is not unusual for IBM. In fact, the IBM PC, when first introduced, was considered expensive in relation to the rest of the market.

As we have said, PC*jr* really breaks new ground in the home computer market. PC*jr* is the first home productivity computer. Because it is unique, to compare its price with those of other current home computers is unfair. Nevertheless, the relatively high price of PC*jr* has lead to speculation that IBM has deliberately designed a "price erosion" margin into the announced cost. Observers believe that IBM will drop the price after a year or so, in response to low-priced competition. No one knows whether IBM will do this. The company did drop the price of the basic PC by 15 percent in April, 1983, about 18 months after the machine was first delivered. If this price drop is any indication, a price cut for PC*jr* looks likely at some point, but this possibility should not prevent you from buying a machine today. The cost difference of $200 or less must be weighed against the time delay of a year or more to get the lower price.

Can IBM Succeed Where Others Have Failed?

The answer to this question, in a word, is "yes." Success in the home computer market is like the old problem of the chicken and the egg. A computer needs software to become popular, but software is only written for popular machines. This trap has doomed many home computer manufacturers before.

IBM will succeed in the home computer market for a number of reasons. First, the PC*jr* is compatible with the IBM PC. PC*jr* also

offers a wide variety of software for every home computer application. Then, too, IBM is dedicated to providing full service and support for the machine. Last, but not least, PC*jr* will succeed simply because of the name "IBM."

Compatibility

Probably the most important factor in the success of PC*jr* will be its compatibility with the IBM PC. No doubt, thousands of buyers will be like our fictional character Molly Roberts who uses a PC at work and wants a compatible machine at home. For now, there is only one computer for them—PC*jr*. People who have already learned to operate an IBM PC will find PC*jr* easy to learn and fun to use.

Compatibility will probably also benefit the IBM PC. In time, people who buy PC*jr* for home use will decide to purchase a larger computer for the office or lab, or for a charitable group or club to which they belong, etc. As these persons move into desktop computing, most will choose to buy IBM again.

Software Variety

On the same day that IBM introduced the IBM PC, the company also released a family of popular software for the computer. This family included well-known programs like Microsoft BASIC, VisiCalc, and Easywriter. IBM knew that without software their PC would be just another high-priced box.

IBM repeated its wise move with PC*jr*. The computer had a library of over 25 programs the day it hit the market. No one will have to ask, "What can I do with this machine?" The answer exists in the form of dozens of popular software packages for personal management, entertainment, programming, and education.

Because PC*jr* is compatible with the IBM PC, the PC*jr* will quickly acquire one of the largest libraries of software available for any home computer. IBM has already made a number of IBM PC programs available. As we have seen, many of the non-IBM programs that run on the PC—programs like WordStar® and SuperCalc—will likely be converted to run on the PC*jr*.

IBM Name

One of the most important points in PC*jr*'s favor is the "IBM" name. IBM is identified by millions of potential PC*jr* buyers as *the* name in computers. As we have seen, many PC*jr* purchasers will have been exposed to IBM micros, minis, or mainframes at work. For these people, IBM is the natural place to go for a home computer. The success of the IBM PC has demonstrated the importance of this factor.

The name IBM may be the strongest assurance of success for PC*jr*. The strength of the company's name is the only way to explain the incredible impact PC*jr* had in the home computer industry months before its introduction. Both industry analysts and home computer buyers believed without seeing that the IBM "Peanut" would be *the* home computer to buy. The hidden message is: "If IBM does it, it will be done right, and it will be successful."

Full Service

The name IBM also implies expert, reliable service and thus creates high buyer confidence, which is another element in PC*jr*'s favor. IBM's founder, Tom Watson, instilled his company with a "customer first" attitude that survives to this day. This attitude is reflected in PC*jr*'s one-year warranty, the first in the home computer industry. IBM's high standards for potential PC and PC*jr* dealers also exemplify this attitude. The company knows its customers want to feel secure in their home computer buying decisions, and they have moved to offer those assurances.

Economies

Once a computer becomes popular, the manufacturer can build in sufficient volume to keep costs low. As all of these factors combine to make PC*jr* the most popular home computer around, IBM will begin to realize enormous economies of scale in production. Because IBM will be making so many PC*jr*s, it will be able to make each one very inexpensively.

Having the lowest cost is good for two reasons. First, lower costs mean higher profits. As long as IBM maintains its current price

structure, the company is sure to make an attractive profit on PC*jr*. Low costs also give a company room to maneuver. If a competitor enters the market at a low price, IBM will have the margin to match or beat those price cuts. Competing with IBM on the basis of price will be virtually impossible (once the company decides, in fact, to compete on that basis).

Conclusion

Never has a product been so long expected and so widely feared as PC*jr*. It is one of the most exciting new commodities ever seen in the home computer industry, and PC*jr* is sure to become one of the most popular home computers ever.

If you are in the market for a home computer, you will not be likely to make a better purchase than an IBM PC*jr*. It offers all of the features you need. If you have already bought a PC*jr*, congratulations! If you are about to buy one, good luck and have fun!

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IBM PC*jr* Favorite Programs Explained

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If PC*jr* is your first computer, this book offers an introduction to the world of personal computers. Inside you'll find valuable information on how to use a personal computer and explanations of many computer terms and concepts. A discussion of PC*jr*'s disk operating system, PC DOS 2.1, and an explanation of cassette and cartridge BASIC are also included. To help you evaluate and understand PC*jr*, *Introducing IBM PC*jr offers comparisons between PC*jr* and other popular small computers.

If you own a PC*jr* or are considering buying one, this book is for you!