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ABSTRACT

Written for elementary and secondary school teachers with little or no experience with the computer, this book provides an overview of the computer and the role it can play in the classroom. An introduction presents a brief history of computing and a brief discussion of computers in society and computer literacy. Individual chapters cover hardware, software and educational applications of computers, including drill and practice, tutorials, computer managed instruction, simulations, computer games, problem solving, LOGO programming language, word processing, the electronic blackboard, classroom testing, and vocational guidance. A chapter on using a computer in the classroom addresses preparing yourself, establishing objectives and learning outcomes; acquiring hardware, software, and courseware; setting up your computer facility; planning and presenting activities; and evaluating courseware. A brief chapter is included for principals and vice-principals. Thirty-two references are listed. Also included are a list of 19 selected periodicals and a glossary of computer terms. (LMM)

COMPUTER AWARENESS:

AN INTRODUCTION FOR TEACHERS

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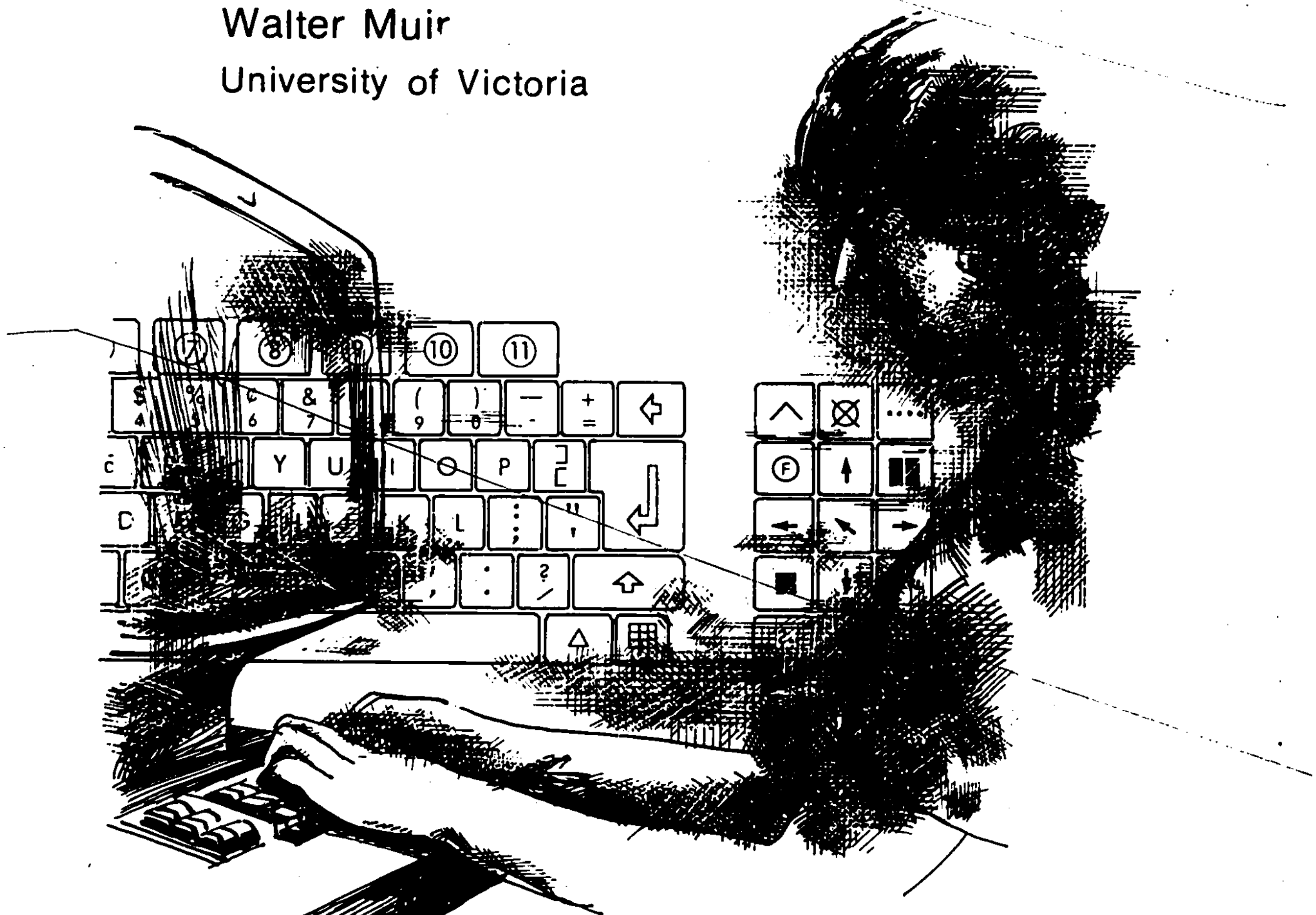
University of Victoria



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CONTENTS

PREFACE

We are living in the midst of the "computer revolution", and like most revolutions, no one can predict just where it will take us. We do know, however, that computers are here to stay. They mean business, in every sense of the word. More and more, our daily lives are affected by these electronic marvels; from shopping for groceries, to paying our bills, to protecting our homes, to sorting our mail, to sawing our lumber, to building our cars, and on, and on. The growth of computer applications over the past decade is unlike anything yet witnessed by modern civilization, and there is no apparent limit to what we can expect in the future.

The computer revolution seems to have caught the field of education somewhat by surprise. We knew about computers, of course, but because they were so expensive there seemed little reason to think they would come into our classrooms, at least not for some time to come. The microcomputer has changed all that. Over the past three or four years, these sophisticated little devices have been finding their way into homes, as well as schools, at an astonishing rate. The computer, once the subject of science fiction, has become commonplace.

This book has been written for those elementary and secondary school teachers who have had little or no experience with computers, but are interested in knowing something about them and some of the things they can do. When you have finished reading the book, you should have a reasonable overview of the computer and the role that it can play in your own classroom. You should also have a good idea as to whether or not you want to get involved in using computers yourself.

A note of sincere appreciation is extended to the Mathematics Advisory Committee on Assessment and Curriculum, of the B.C. Ministry of Education, for the advice and support received from the Chairman and Members of the Committee.

Walter Muir

Victoria, B.C.

CHAPTER ONE

INTRODUCTION

If you are like most teachers you are skeptical, perhaps even apprehensive, about the arrival of computers in our schools. There is nothing wrong with healthy skepticism, as long as it is based on understanding. The purpose of this booklet is to reduce your concerns about computers by informing you about them, and by suggesting ways in which you might apply what computers have to offer in your own classroom. You probably see this as a somewhat overwhelming task, but, if you are willing to spend some time and effort learning about computers and what they can do, you may find some genuine benefits, for both you and your pupils. Be forewarned, though, computers can be addictive - you need only watch youngsters at a MICROCOMPUTER or a video game to be convinced of that. (By the way, when you see a capitalized word in the text, it is usually defined in the Glossary at the back of this booklet.)

A BRIEF HISTORY OF COMPUTING

Our prehistoric ancestors had a very simple method of expressing how many mastodons they had killed when the hunt was over - they used their fingers, or an appropriate number of stones or sticks. Then along came that oriental masterpiece, the abacus. This was undoubtedly in response to the fact that one runs out of fingers when trying to represent quantities greater than ten. The abacus was a major technological breakthrough and it is still effectively used in many parts of the world. The abacus has its limitations, though, and it never did become popular in the western world. Instead, western commerce depended upon handwritten symbols (numerals) that could be manipulated according to specific operations (adding, subtracting, multiplying and dividing).

Hand calculations, as we all know, are slow and inaccurate and about 1640, Blaise Pascal, a brilliant French mathematician, devised what is considered to be the first mechanical numerical calculator. However, unlike the rapid technological developments we have seen over the last decade, Pascal's invention failed to demonstrate its usefulness at the time and it was not widely used.

The next notable development did not take place until about 1800 when Jacquard, also in France, invented a textile loom that produced intricate patterns under the control of punched cards. This proved to be a very important contribution to the industrial revolution because it immediately increased the efficiency of textile production.

About 20 years later, Babbage, in England, designed what he called a "differential engine."

The plan for this device is considered to be the first description of what a modern computer would ultimately be able to do. The technology of the day, unfortunately, was not capable of building Babbage's engine, so it never really left the drawing board.

Next in the evolution of computers was the invention of an electrical tabulating machine by Herman Hollerith in the United States. This device applied the punched card concept of Jacquard to the coding of the data from the U.S. Census of 1890. Hollerith's machine was able to provide much more census information than previously in about one third the time. Indeed, without Hollerith's invention the tabulations for the 1890 Census would not have been completed until well after the 1900 Census had been carried out. Hollerith formed a company to develop and sell his invention - this company eventually became a world leader in computers, IBM.

Several other companies were formed to produce mechanical calculating equipment for the growing commerce of the 20th Century. These calculators were based, essentially, on the ideas of Pascal, and were instrumental in establishing a new industry which prospered until about 1970, when electronic calculators came onto the market.

In the mid 1930's researchers at several locations worked on the idea that electronic vacuum tubes could be used to provide a substantial increase in the speed with which arithmetic calculations could be carried out. By the early 1940's the first electronic "computers" had been built. They were huge devices that required great amounts of electrical energy, both to run the computer and to keep it cool. They were also very difficult to program. However, the Computer Age had begun and developments in computer technology have since progressed at an amazing rate.

The next critical event was the production of the transistor, about 1950, which performed the function of the vacuum tube, but did so more reliably and with the consumption of much less electrical energy. Then, largely to meet the needs of the U.S. Space Program for smaller and lighter components, the transistor was replaced by the integrated circuit or CHIP which has steadily been improved to the point where thousands of circuits can occupy an area the size of a pinhead.

The computer of today is a direct descendant of those early attempts to improve methods of counting and calculating. But modern computers can do much more than count and calculate.

COMPUTERS IN SOCIETY - TODAY AND TOMORROW

The growing influence of computers in our modern society can be seen almost everywhere. During the past decade the cost of computing has been dramatically reduced while the cost of human labor has steadily grown. It has been suggested, for example, that had the automobile industry experienced a similar reduction in costs, a luxury car could be now bought for less than one dollar. This is why we are witnessing the amazing growth of computer applications in business, industry, government, and education. The range of applications is expanding so rapidly that only those who work with computers on a full-time basis are able to keep abreast of the most recent developments.

The following are some aspects of our day to day lives that involve computers in one way or another:

*Airlines - reservations, ticket preparation, seat assignment

*Aircraft - automatic flight control, landing control

*Automobiles - ignition systems, status information

*Banking - accounting, funds transfers, automatic tellers

*Business - accounting, word processing, communications

*Design - buildings, bridges, roads, equipment

*Entertainment - games, movies

*Graphics - TV commercials, photographic enhancement

*Home - security, food preparation, budgeting & accounting

*Manufacturing - process control, robot welders & assemblers

*Medicine - diagnosis, patient monitoring, record keeping

*Pharmacy - control of prescribed drugs

*Police - data banking, identification, fingerprint analysis

*Retail - checkout scanning, inventory control

This list is far from complete, but it clearly illustrates the extent to which computers have entered our lives. Further, it must be recognized that the influence of computers is really in its infancy. As they increase in their ability to perform more sophisticated functions, computers will assume a growing role in our society. For example, there is TELIDON, Canada's "videotex" system which can provide information on virtually any topic, from airline schedules to zoo attractions. Proponents of videotex claim that it could ultimately supply all the information the average person wants to know. It will also provide for shopping at home, for electronic mail services, and, incidentally, for the education of children in their own homes.

Information will continue to be stored in computers to the point where virtually everything that is known will be found in computer data banks. This, of course, presents us with a dilemma. On the one hand, humans are information seekers and computers do provide for the efficient storage and retrieval of all sorts of data. On the other, the privacy of individuals can be easily invaded for unscrupulous reasons unless adequate controls are developed. Hopefully, appropriate actions will be taken to ensure that the benefits will far outweigh the risks.

The developing VIDEODISC technology, when used under computer control, will become an important component in the storage and retrieval of information. It should be possible to store copies of all the printed material ever published on as few as 200 video-discs. These could be stored in a room the size of a broom closet and the information they contain would be available to almost anyone.

Money, as we know it, will probably disappear. Instead, each person will likely carry a single plastic card, carefully coded for security purposes with a fingerprint or a voiceprint. These cards will allow a computer terminal at the checkout counter of any retail store to transfer funds from the bank account of the purchaser to the store. It won't even be necessary for a clerk to perform the transaction since the customer will simply pass the merchandise over an automatic scanner. No item in the store will pass through the outer doors without setting off an alarm unless the checkout terminal has reset the security code embedded in the article.

Computers will respond, more and more, to simple voice commands. Instead of using keyboards for entry, a microphone is all that will be necessary. Information will be requested, orders for goods and services will be given, and correspondence transmitted, over telephone lines. The conversation will be with a computer, however, not another person.

All of this is very interesting, you may say, but at what cost? Well obviously there will be some costs, but most experts in computer applications argue that the advantages will far outweigh the disadvantages. Individual freedoms may be placed at risk through greater access to personal data, but this should be counterbalanced by the opportunity for planners and political leaders to have more reliable information upon which to make important decisions. Furthermore, it is argued, adequate measures can be taken to prevent access to an individual's data by the wrong people.

Computer crime, however, is already a "growth" industry. What this means is that the theft of money from banks and other financial institutions, through illegal access to computers, is steadily increasing. Great efforts are being made to prevent access to bank accounts by unauthorized people. However, since the evidence suggests that most of these thefts are carried out by persons who have "inside" knowledge of the system, efforts to prevent theft have not been entirely successful.

The impact of computers on employment patterns has already been considerable. Many relatively low skilled jobs, such as filing office records and assembling automobiles, have been dramatically affected by computers designed to perform these activities much faster and with greater precision than humans. The critical question is, how will people be trained to function effectively in the age of computers? Surely, this is a question about which all educators must be concerned.

COMPUTER LITERACY

Just as the Industrial Revolution created the need for a "literate" populace that could understand and work effectively with machines, the Computer Revolution has created the need for people who are skilled in the use of computers. The term, "computer literacy", therefore, refers to a general understanding of computers, and the ability to use them in meaningful ways.

Until the mid 1970's, most persons who used computers were either graduates of "computer science" programs offered by universities and colleges, or had been trained by large businesses that required skilled programmers. This is how the initial needs of business and industry for "computer professionals" were met.

Microcomputers, however, have greatly broadened the base of computer applications since they are capable of most of the functions previously carried out only by large computers. Complex applications, such as bookkeeping for small and medium sized businesses, which previously were performed by large commercial computing services, are increasingly being carried out in the office on microcomputers. As a result, there is a rapidly growing need for computer literacy in the general population.

The impact of microcomputers on the field of education has been equally dramatic. When computer science courses were introduced to high schools prior to 1970, only very large school districts could afford their own computing systems. The only alternative was to rent "time", if possible, on a nearby university or business computer. This meant that many students had no opportunity to learn about computers until they attended university. Now, because of the relatively low cost of microcomputers, virtually all high school students, most junior high students, and many elementary school students have access to the latest in computer technology. It is now possible, therefore, to begin the development of computer literacy with pupils in the elementary school.

The question is, who is going to teach computer literacy? The answer, believe it or not, is that every teacher is potentially a teacher of computer literacy. First, however, teachers must become confident in their own ability to use computers. The following is suggested as a basic list of objectives for a computer literacy program.

Specifically, the "computer literate" teacher will have:

1. Knowledge of the history of computing;

2. An understanding of the components of a computing system;

3. An awareness of how computers function and how they are programmed;

4. An understanding of the range of computer applications to the classroom, and the ability to apply them;

5. An awareness of the sources of hardware and software;

6. The ability to evaluate the effectiveness of programs and applications;

7. Knowledge of business and industrial careers in computers;

8. An awareness of the present and possible future effects of computer technology on society.

While this may seem to be an imposing list, these objectives can be attained by anyone who is willing to apply the necessary time and effort. The major purpose of this booklet is to assist the teacher with no background in the use of computers to begin to acquire a useful level of computer literacy.

CHAPTER TWO

HARDWARE

The Nuts and Bolts of Computers

The term, HARDWARE, is used to describe the physical components of a computer system; those parts that can be seen and touched. As can be seen in Figure 1, there are four main types of hardware; INPUT UNITS, OUTPUT UNITS, (which are also called PERIPHERALS), the CENTRAL PROCESSING UNIT or CPU, and the MEMORY UNIT.

INPUT UNITS

The computer will accept information from a wide variety of sources, as long as it arrives in the form of numbers, letters of the alphabet, or special characters such as question marks and parentheses(?), commas, and periods. Information entering the computer is called INPUT.

With microcomputers, the most frequently used input unit is a KEYBOARD which is very similar to the traditional typewriter keyboard, but with a few special keys added. When a given key is struck, the computer instantly stores the code corresponding to that key in its memory. A series of keystrokes can input numbers like "123.45", words such as "RUN", or special characters like "(#$%&*)." The sentence you are now reading, for example, was originally entered into a microcomputer through its keyboard.

DISK DRIVES and CASSETTE DECKS provide input in a rather special way. Programs and data can be stored on DISKETTES or audio CASSETTE tapes for future use. When the user wishes to retrieve a program that has been stored previously, it is simply necessary to instruct the computer to "load" the program into the computer's memory from either of these input units. Thus, programs and data are quickly made available for use by the computer. It should be noted that disk drives are usually preferred over cassette decks in that they retrieve programs and data much faster and are generally easier to use. However, disk drives are rather more expensive than cassette decks.

GAME PADDLES and JOYSTICKS are also input units. As their names imply, these devices permit the user to play many of the popular computer games by inputting information that controls the movement of "objects" about the screen. The principle involved is similar to controlling the loudness or volume of a radio - as the nob or stick is moved, the computer recognizes different values and responds to them.

CARD READERS have long been used as input units to large computers. Jacquard's early invention has remained a very useful method of data input. High speed card readers can process over 2,000 cards per minute. Card readers are particularly useful for entering large amounts of data.

OPTICAL SCANNERS permit the input of a variety of information such as the "bar code" on a retail item, the specially formed numbers at the bottom of a bank cheque, or the print on a ordinary typewritten page. Most of these scanners are very expensive and are not often used with microcomputers at this time.

There are several other input devices used with microcomputers including GRAPHICS TABLETS which can convert the output screen into an artist's canvas, and LIGHT PENS which allow very young children to communicate with the computer by simply pointing at various locations on the screen. In addition, there are MUSIC SYNTHESIZERS which, when coupled with a piano-like keyboard, can transform a microcomputer into a very sophisticated musical instrument.

OUTPUT UNITS

Information leaving a computer is called OUTPUT. Most microcomputers, and indeed most computers of any size, use a television screen, or MONITOR, as the main output unit. These are also called CATHODE RAY TUBES, (CRTs), or VIDEO DISPLAY TERMINALS (VDTs). They have the advantage of very quickly presenting the results of the computer's activity. Many CRTs are capable of providing output in various colors, while others have black and white or green and white screens. The major disadvantage of the CRT is that it can present only a limited amount of data at one time, and when the power is shut off the display disappears. Output to a CRT is sometimes referred to as SOFTCOPY.

When more permanent output, or HARDCOPY, is required from the computer, it is usually directed to a PRINTER. There are several types of printers, the most common of which, as far as microcomputers are concerned, is known as the "dot matrix" printer. These devices, which can print up to 600 words per minute, form characters by pressing a set of needles forming the desired shape against a carbon ribbon which, in turn, presses against the paper. In addition to printing numbers, letters, and special characters, these printers can also output graphic designs, some examples of which follow. Other printers are very much like typewriters connected to the computer. These produce output that is exactly as you would obtain from a typewriter. What you are reading now was originally output onto a high quality printer of this type. Large computing centres, which produce great amounts of printed output, now use "ink jet" and "laser" printers that can output in the order of 20,000 lines per minute.

Disk drives and audio cassette decks are output as well as input devices. Here again, disk drives are much easier to use than cassettes. However, both are capable of storing programs and very large sets of data for future use. Each side of a diskette, or FLOPPY DISK as it is also called, is capable of storing over 500,000 letters or characters. This total storage capacity of more than one million letters is

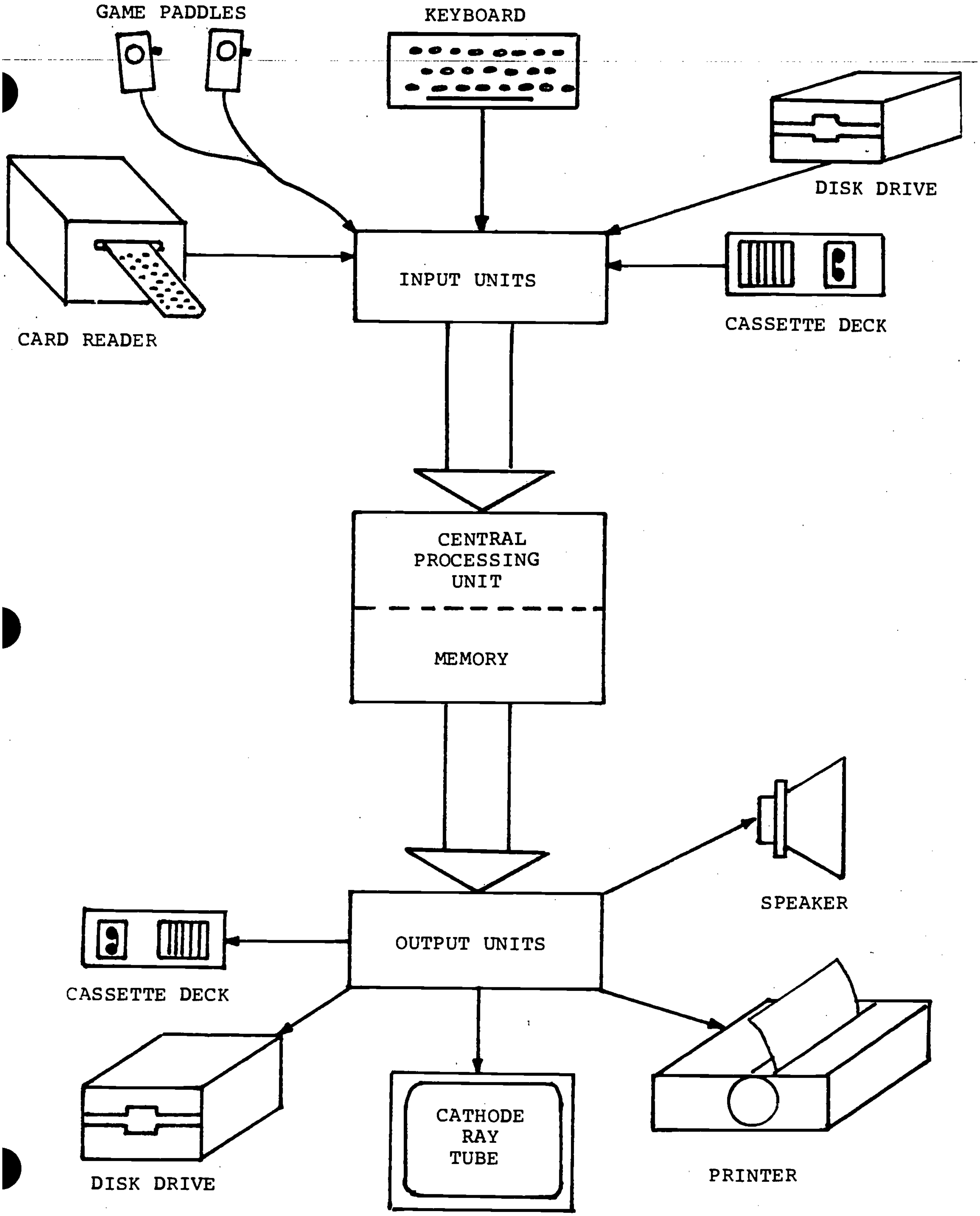


Figure 1. A Microcomputer System

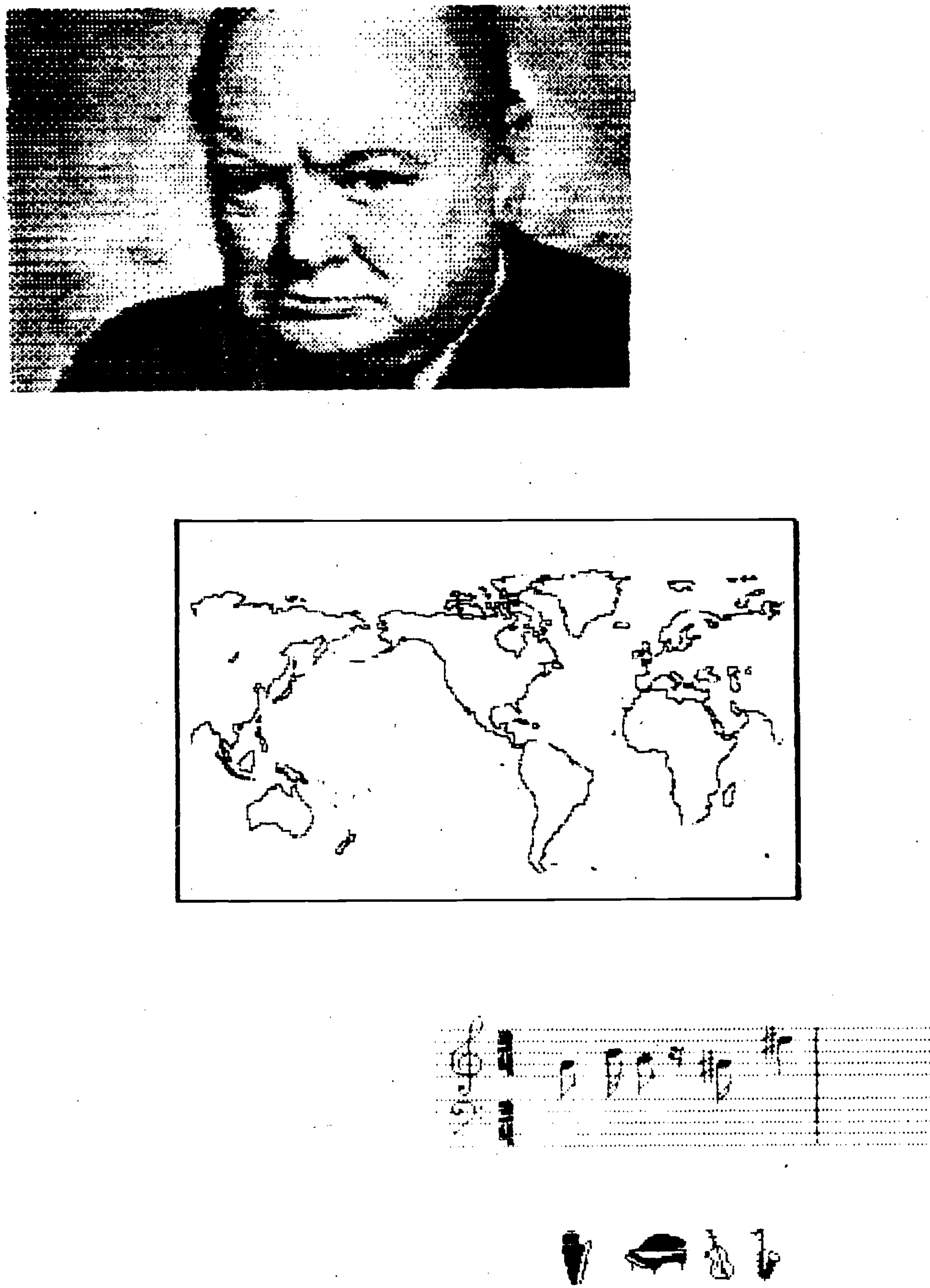


Figure 2. Graphics Output By A Dot-matrix Printer

approximately the equivalent of a lengthy book.

Other output devices include; PLOTTERS which can "draw" precise designs, such as the plans for a building, and can do so in several colors, SPEAKERS which provide "sound effects", and music synthesizers which output music into a regular stereo system. Computers can also synthesize the sounds of a human voice to permit direct communication with humans over the telephone. Many other output devices perform a variety of special functions, and more are steadily being developed.

THE CENTRAL PROCESSING UNIT

The "brain" of every computer is the Central Processing Unit, or the CPU as it is most frequently called. The CPU is a specially designed integrated circuit, or MICROPROCESSOR, that controls all of the activities performed by the computer. The CPU has two basic components: a "control unit" which responds to instructions provided by a program; and an "arithmetic unit" which performs the required calculations at extremely high speed. The microcomputer became possible only after a reliable and inexpensive CPU was developed. The CPU for a microcomputer can cost as little as $10; a remarkable price for such a sophisticated piece of hardware, since the CPU in most microcomputers can perform as many as 500,000 calculations in a single second. While that is very fast, the CPUs of the world's fastest computers are over 1,000 times faster. It is this fantastic speed that distinguishes the capability of the computer from that of humans. Keep in mind, however, that computers can't think for themselves; they depend entirely on human programmers for the "intelligence" they appear to have.

THE MEMORY UNIT

There are two types of memory in most microcomputers. The first is called "read only memory", or ROM, and it remains in the computer even after the power has been shut off. ROM chips contain special programs that are prepared by the people who manufacture the computer. When you switch on the power to a computer, the programs in ROM respond automatically to bring the computer to a state of readiness. In other words, ROM provides for the basic functions of the computer. Hand-held calculators also operate by means of ROM chips.

The second type, "random access memory" or RAM, is used to store programs and data that are input into the computer. The contents of RAM, however, is lost the instant the computer is turned off. For this reason, the information contained in RAM is usually stored, prior to turning off the power, either on a diskette or a cassette. RAM, then, is designed to hold information only during the time that the computer is functioning. Each piece of information stored in RAM can be identified and operated upon by the CPU. Programs and data are stored in RAM at the same time. When programs operate on data, the computer is doing its job.

The memory capacity of a computer is usually described in terms of the amount of RAM its memory unit contains. In most microcomputers, each memory location in RAM is capable of storing one character (the word "character", for example contains nine characters - count them!). In computer terminology, the amount of RAM required to represent one character is called a BYTE. A byte is composed of eight BITs, or Binary digITs, which represent the unique code for each character as a series of 1's and 0's. The letter "A", for example, can be represented as 01000001 in the computer's memory, and the letter "B" as 01000010, etc. A "kilobyte", or K, of memory contains 1024 bytes (1024 is equal to 2 raised to the 10th power). Most of the microcomputers now in our schools contain from 16K (16,384) to 64K (65,536) bytes of RAM.

SUGGESTED ACTIVITIES

1. Arrange a visit to the classroom of a teacher who is presently using a microcomputer. Observe how the computer is being used in the classroom and get as much information as you can from the teacher and the pupils.

2. Visit a nearby business or industrial firm that uses a computer. You will find that most people who work with computers are very pleased to talk about them and how they use them in their businesses.

3. Begin reading computer publications that are directed at teachers. A list of some of these can be found in the Appendix.

CHAPTER THREE

SOFTWARE

The Means to an End

Without a specific set of nstructions in its memory, a omputer cannot accomplish any- hing. This is where SOFTWARE nters the picture. Software efers to any PROGRAM that is tored in a computer that nstructs it to perform a given ask. When you reserve an air- ine flight, for example, a pro- ram first of all determines hether there is room for you on he flights you want. If there s room, the program then asks or your name, address, business hone number, home phone number, nd method of payment. It then onfirms your reservation and can mmediately print your ticket on nearby printer. On the day hat you travel, the check-in ttendant enters your name into he computer which re-confirms our reservation, gives you your eat selection, and then adds our name to the passenger list. his occurs because a program was lesigned and written by a human ROGRAMMER.

A computer program is a proce- lure, or ALGORITHM, that nstructs the computer in every letail of its task. To accom- lish this, a programmer will use ne of the many COMPUTER ANGUAGES that are available. As ar as microcomputers are con- erned, the most frequently used anguage is BASIC (Beginners ll-purpose Symbolic Instruction Code).

BASIC was developed in the early 1960's as a computer language that could be used by people who were not "computer scientists." Also, it was designed to be an "interactive" language that permitted both programmers and users to sit at a keyboard and communicate directly with the computer. The interactive concept is commonplace now, but it was a major breakthrough in the evolution of computers. The fact that BASIC is the language of most microcomputer programs today is a reflection of this earlier development.

There are, however, several different "dialects" of BASIC. Each microcomputer manufacturer tends to have its own version of BASIC, and programs that will function on one computer will not normally do so on another. The need for "compatible" software largely explains why a given school, school district, or even an entire province, will seem to prefer one model of microcomputer over another. It is simply too difficult and expensive to maintain a full range of software for two or more models of microcomputer. Fortunately, it now appears that some microcomputer manufacturers are beginning to move toward a degree of software compatibility by means of "translation" devices.

PROGRAMMING

Most microcomputers are capable of performing a broad range of "arithmetic", "logical", and "process" operations. Arithmetic operations refer to addition, subtraction, multiplication, division, exponentiation, and the like. Logical operations include determining whether one value is equal to, greater than, or less than, another. And process operations involve input to and output from the computer.

A competent programmer will have a thorough knowledge of a computer language including its vocabulary (the symbols it uses) and its syntax (its rules of expression). In many ways, learning a computer language is like learning a common language such as English or French.

Before a program is written, some thought must be given to the procedure that the computer is expected to follow. A FLOWCHART should be developed to guide the programmer in writing the program. This is similar to making an outline of a topic and then writing an essay based on the outline.

Following, is a flowchart for a simple program that will calculate the average of a set of five numbers. When the flowchart is complete, the programmer can then translate it into one of several programming languages, in this case BASIC. A LISTING of the program that will instruct the computer to calculate the average is on the page following the flowchart. At the bottom of the page are two examples of input to and output from the computer, as the program was run. You should be able to follow the flowchart since it is composed of words common to all of us. The shape of each box in the flowchart indicates the type of operation contained in it. The arrows indicate the direction of "flow."

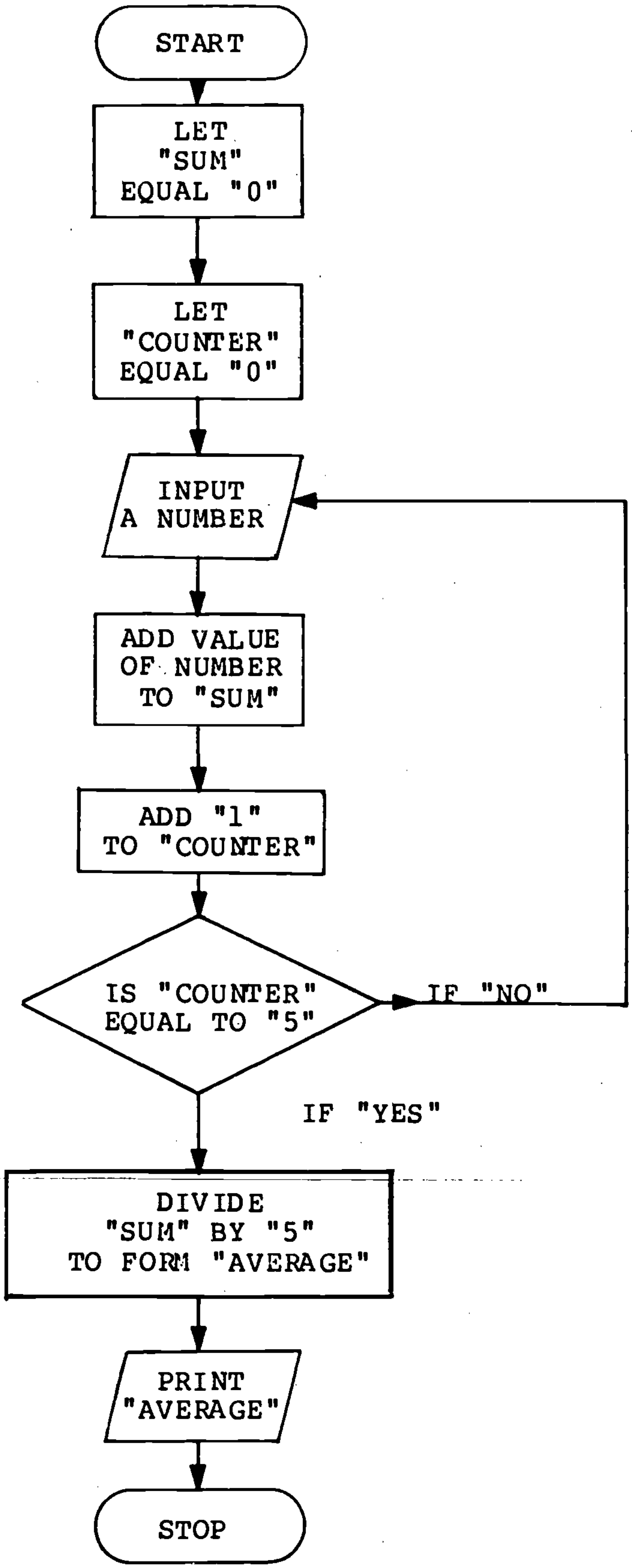
Now, if you look at the program listing, you should be able to follow the translation of the flowchart into the BASIC language. First, note the numbers that increase from 10, 20, to 140, 150. These are called "statement numbers", and they tell the computer the order in which the statements are to be interpreted. The first five statements (10 to 50) are remarks (REMs) which provide DOCUMENTATION for the program; that is, they describe what the program is intended to do. REMs, by the way, are ignored by the computer, since they are only intended for the use of humans. The remaining statements (60 to 150) correspond directly with the flowchart.

Beneath the program is what you would obtain if you were to RUN the program and enter, in succession, the numbers 1, 2, 3, 4, and 5. The question marks (?) indicate when the program requires a number to be input. The calculated "average" (3) is then printed and the program stops. The second example calculates the average of a completely different set of numbers.

If you have understood this, you are well on your way to becoming a computer programmer. When you have access to a microcomputer, you should try out your new found skill. Simply type in statements numbered 60 through 150 from the program listing, and

A FLOWCHART

To Calculate the Average of Five Numbers



THE PROGRAM LISTING

```
 10  REM  ****************************
 20  REM  * THIS PROGRAM CALCULATES   *
 30  REM  * THE AVERAGE OF 5 NUMBERS *
 40  REM  ****************************
 50  REM
 60  LET SUM = 0
 70  LET COUNTER = 0
 80  INPUT NUMBER
 90  LET SUM = SUM + NUMBER
100  LET COUNTER = COUNTER + 1
110  IF COUNTER = 5 THEN GOTO 130
120  IF COUNTER <> 5 THEN GOTO 80
130  LET AVERAGE = SUM / 5
140  PRINT "THE AVERAGE IS "; AVERAGE
150  END
```

RUN the Program a couple of times, and this is what will happen!

```
RUN                     RUN
?1                      ?75
?2                      ?116
?3                      ?375
?4                      ?567
?5                      ?1098
 THE AVERAGE IS 3        THE AVERAGE IS 446.2
```

RUN the program. If you have typed correctly, it should give you identical results.

BASIC is only one of several programming languages that are available for microcomputers. Other languages include, FORTRAN, (FORmula TRANslation), which is very similar to BASIC, PASCAL, (named for the mathematician), PILOT, (Programmed Inquiry, Learning Or Teaching), and LOGO, a language specially designed to permit very young children to program computers. PILOT and LOGO are described more fully in Chapter Four.

This booklet is not intended to teach you how to program a computer. The fact is, YOU DON'T HAVE TO WRITE YOUR OWN PROGRAMS TO USE A MICROCOMPUTER EFFECTIVELY IN YOUR CLASSROOM. There are literally thousands of useful programs already written for most microcomputers. However, there are obvious advantages in knowing something about programming, if only to better understand how a computer works and to recognize the effort required to write a good program. Most manufacturers of microcomputers provide tutorial booklets that take you by the hand through the intricacies of programming. In addition, there are many excellent books on the market that do the same. Some of these are included in the Bibliography. You should also consider enrolling in a course or workshop that will more formally introduce you to the use of computers. These are offered through school districts, teachers' associations, institutes, colleges, and universities. In the meantime, if you read on in this book you should obtain an overview of what computers can do, and how you can use them in your own classroom.

SUGGESTED ACTIVITIES

1. Develop a flowchart for an activity you do on a regular basis such as starting and driving your car to work, or looking a word up in the dictionary. You may be surprised how easy it is to overlook an essential component.

2. Contact a colleague or friend who has a microcomputer and have him or her assist you in writing a short program. If you show an interest in programming, most "programmers" are pleased to help.

CHAPTER FOUR

THE ROLE OF COMPUTERS IN EDUCATION

THE COMPUTER AS AN AID TO LEARNING

COMPUTER ASSISTED INSTRUCTION (CAI) has been used very successfully by universities, by business and industry, and by the military, since the 1960's. At many universities, complete courses, taken for credit, are taught by CAI. PLATO, which was developed at the University of Illinois, is one of the most comprehensive CAI systems available today; it can be purchased as a complete package, including computer, peripherals, and programs, for about $3 million. PLATO systems, in use throughout North America, provide effective instruction in medicine, engineering, physics, chemistry, creative writing, and many other disciplines. For example, medical students can examine, diagnose, and prescribe remedies for "patients" who exist only in the computer. The students ultimately do the same for real patients, but only after they have mastered the procedures on the computer.

Other CAI systems are used by computer manufacturers to update their technicians in the maintenance and repair of new equipment, by airlines to train pilots, and by the military to introduce recruits to the principles of modern warfare, to mention but a few.

The high costs of hardware and software have generally prevented the public schools from using CAI extensively. Only very large school districts have been able to establish CAI systems in their schools. The arrival of the microcomputer, however, has significantly reduced the cost of CAI. Now, many sophisticated CAI programs are within the financial resources of most school districts.

CAI is but one of several terms which are used to describe the interaction of a learner with a computer. Other terms you will encounter include, COMPUTER AIDED LEARNING (CAL), COMPUTER BASED INSTRUCTION (CBI), and COMPUTER ENHANCED LEARNING (CEL). For the purposes of this presentation, the term CAI will be used to include all of these.

A large amount of research into CAI has been carried out over the past 20 years, most of which has shown that well-designed CAI is at least as effective as the traditional methods of lecturing and note taking. CAI also has been shown to be more efficient in that identical material can be learned in as little as half the time. A further benefit, particularly to slower learners, is provided by the fact that CAI allows each learner to proceed at his or her own rate while the computer acts as a patient tutor.

There are other facets to the

use of computers that can complement the teacher's role in the classroom. The remainder of this chapter provides an overview of these.

DRILL AND PRACTICE

How often have you thought, "If only I had the time to go over several examples of this concept with Johnny?" Often a CAI program can give Johnny most of the individual attention he needs to acquire basic skills, in arithmetic for example, and free you from the feeling that he is being neglected.

DRILL AND PRACTICE is considered to be the lowest level of CAI, but it is probably the one most frequently used by classroom teachers. There are several reasons for this: useful programs are relatively easy to create; there are many programs available to teachers at relatively low cost; they are relatively easy to use; and they are effective when used properly.

Drill and practice routines are used mainly in the development of basic skills in such areas as vocabulary, spelling, arithmetic operations, geometric and algebraic relationships, balancing chemical equations, etc. In other words, in circumstances where repetition can improve the learning of operations and concepts.

In the typical drill and practice sequence a question is presented to the student and the computer waits for a response to be made. The response is immediately evaluated by the computer program as to its correctness and, on the basis of that, feedback is given to the student. If the response is correct, positive reinforcement is given verbally, graphically, auditorilly, or in some combination, and the program proceeds to the next question. If the response is incorrect, the student is so informed and the question is presented again. If, after the second or third attempt the student has not provided the correct response, the program usually presents the correct response which may be accompanied by suggestions as to why the student may not have understood the concept. Examples of drill and practice exercises, as the learner would see them on the CRT screen, follow.

TUTORIALS

When a learner is presented with new information by a computer and is regularly tested to determine whether the information has been learned, then CAI is functioning in the TUTORIAL mode. This, of course, is very similar to the situation where a student has direct interaction with a human tutor. The effectiveness of CAI as a tutor depends on the attention to detail given to creating the learning program. The best tutorials are capable of taking a learner from virtually no knowledge of a topic to a very high level of understanding. In other words, CAI tutorials can provide for a total learning experience. Many CAI tutorials, however, are little more than "page turners"; programs that simply present verbal material that could be effectively presented in a textbook, at less cost. In planning CAI sequences, the question that should always be asked is, "can CAI improve

EXAMPLES OF DRILL AND PRACTICE QUESTIONS

```
Which word is correctly spelled?

 1.  computir

 2.  computer

 3.  computar

Enter your choice --> 2

You are correct!
```

```
Subtraction:


  25 - 16 = ?

Enter your answer --> 11

That is not correct!!!

Try again --> 9

Now you've got it!
```

```
On which date did Canadian Confederation
  take place?

 1. July 1st, 1864

 2. January 1st, 1867

 3. July 1st, 1867

Enter your choice --> 2

That is not correct, but you are within
  six months of the correct date.

Try again --> 3

That's correct - very good.
```

upon the learning that would otherwise occur?" If the answer is no, it is probably better to use a traditional approach. However, if the answer seems to be yes, try it, and evaluate the results.

A person who creates CAI tutorials is called an "author", since the process of programming is very much like writing a textbook. Therefore, instead of using a programming language, the author of CAI materials writes in an "authoring language." Authoring languages have been specially designed to facilitate the creation of CAI programs and they tend to be much easier to use for this purpose than are programming languages, such as BASIC. Programs written for CAI are generally referred to as COURSEWARE rather than software, to distinguish the purpose CAI from other computer applications. A related term, LESSONWARE, refers to courseware designed for a single lesson.

When an author prepares CAI tutorials, he or she will develop an "instructional sequence" that presents the learning activities. The following figure illustrates an instructional sequence that is often used for CAI tutorials. The intent of the instructional sequence is to present information systematically, ask questions based on the information, evaluate the student's responses, and provide for additional information if the student's responses are not correct. The evidence is that, as long as the material being presented is new and challenging, the average learner will exhibit greater concentration while interacting with a computer than in the general classroom setting.

NATAL, the "NATional Authoring Language", was developed by the National Research Council of Canada to provide educators with a powerful authoring language. NATAL is capable of recording every response given by every learner and then providing the human instructor of the course with a summary of the responses. In this way, the instructor not only monitors the progress of all students through the course, but also evaluates the performance of the tutorial itself, so that appropriate improvements to the program can be made. NATAL also keeps a record of each student's progress through the tutorial and "remembers" where he or she was at "signoff" and returns there at the next "signon." It also permits tests to be administered, automatically, when a student has completed a unit of study. On the basis of the test results the student may either continue on to the next unit of study, or may be "branched" to a remedial sequence if a preset criterion has not been achieved.

PILOT, "Programmed Inquiry, Learning Or Teaching, is an authoring language that was originally designed for medium and large computers. However, it has recently been adapted to run on microcomputers. PILOT has fewer than 20 commands for the author to use, in contrast to over 100 commands that the programmer of BASIC must learn. A brief sequence of PILOT instructions may be seen under the figure of the instructional sequence.

COMPUTER MANAGED INSTRUCTION

Many teachers have applied the principles of Individually Prescribed Instruction (IPI), or the related Mastery Learning Model, in their classrooms. This involves breaking the content to be learned into relatively small packages or "learning modules." Each module is comprised of a variety of learning experiences such as reading a specified number of pages in a resource book, library research, watching a videotape, etc. Students proceeds independently through successive modules and are tested at the completion of each to determine whether the minimum criterion has been achieved. A major problem with IPI has been the huge amount of "paperwork" required to record the progress of each student. Computers offer the solution since they tirelessly perform such clerical tasks as prescribing learning activities on a daily or weekly basis and administering the criterion tests at the completion of each module. Finally, they can record the results of the test and direct the student to the next set of learning activities. COMPUTER MANAGED INSTRUCTION (CMI) refers to the use of the computer in this way.

There are a number of CAI packages available for microcomputers that are advertised as "management" programs. Most of these are either drill and practice or tutorial programs that simply keep a record of the student's progress. They are not, however, examples of CMI in the broad sense since they rarely, if ever, direct the student to activities that are not computer based. CMI programming is very complex and requires large amounts of memory and disk storage to function effectively, and microcomputers are unable to meet these requirements at this time. However, future developments in hardware will undoubtedly permit the implementation of CMI on microcomputers.

SIMULATIONS

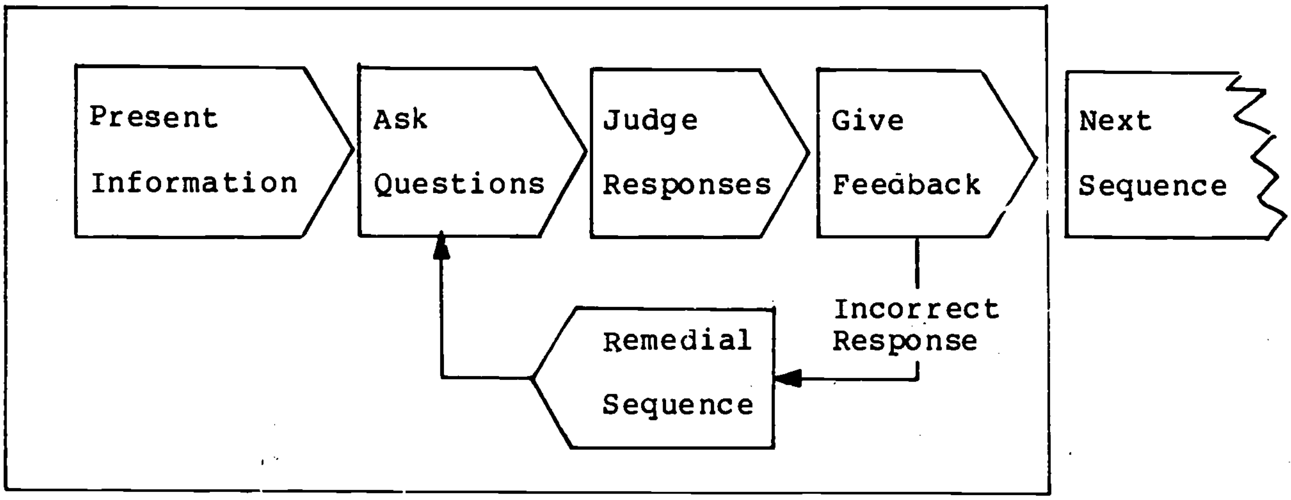
Webster's dictionary defines a SIMULATION as, "the imitative representation of the functioning of one system or process by means of the functioning of another, [for example] a computer simulation of an industrial process." For more than 25 years, computers have been used to simulate a great variety of phenomena including the growth of the world's population, the economies of nations, the ecology of vast land areas, chemical reactions at very high temperatures and pressures, the flight of a jumbo jet, and the functioning of the human brain, to mention but a few. It has been suggested that the computer's most important attribute is the opportunity it presents to develop and test complex models and theories that otherwise cannot be investigated.

Many simulations have been programmed for classroom use. Among these are natural food chains in lakes and forests, stellar constellations, physics and chemistry experiments, genetics laboratories, automotive engines, small businesses, and many others. Well-designed computer simulations can help teachers provide students with unique learning experiences.

COMPUTER GAMES

Most "computer games" are simulations of real or imagined

THE TUTORIAL MODE



The Instructional Sequence

[From Gagné, Wager, & Rojas (1981).]

A SHORT TUTORIAL SEQUENCE IN PILOT

```
*MOUNT                             (Label for this sequence.)

T: Canada's highest mountain       (Display this text on
T: is Mount Logan in the Yukon.     the screen.)
T:
T: Mount Robson, in B.C., is the
T: highest mountain in the
T: Canadian Rockies.
T:
T: What is the name of Canada's    (Ask this question.)
T: highest mountain?
T:
A:                                 (Wait for an answer.)
M: Mount Logan                     (Match answer to this.)
TY: That's correct.                (If correct, type this.)
JN3: NEXT                          (Jump to NEXT label after
                                    three incorrect answers.)
TN: No - try again.                (If incorrect, type this.)
JN: MOUNT                          (Then jump back to MOUNT.)

*NEXT                              (Label for next sequence.)
```

situations. They almost invariably require an intense concentration on the part of persons playing the game. Many games have several levels of difficulty that range from "beginner" to "master", so that skill development can progress gradually. Some of the most imaginative and attractive programs for microcomputers are games, and many have established standards of excellence in general programming techniques.

Whether or not students should be allowed to play computer games in the school is a rather controversial issue at this time. There are teachers who firmly state that, "games have no place in the school environment since the kids get more than enough of them at the video-game parlor." Others, unfortunately, permit students to play games indiscriminately, as long as they don't create a disturbance. These are the extreme positions; the optimum falls somewhere between.

It is obvious that computer games are fun. There seems no logical reason not to take advantage of the strong motivation that computer games have to offer. Many games, such as "Chess", "Adventure" and "Dungeons and Dragons", involve the application of complex logical relationships. Further, many computer games require a very high degree of "eye-hand coordination." Thus, elementary school pupils with psychomotor difficulties can often be assisted in their development through computer games. This is not to suggest that games are necessary to the effective use of computers in the classroom, but rather that there can be substantial benefits if they are used thoughtfully.

Remember that the computer is not a toy; it is a very powerful tool that should be used to its potential. The teacher's responsibility is to ensure that it is used properly and with benefit to all students. This should be a criterion against which to judge whether games, or any other applications for that matter, can be justified.

PROBLEM SOLVING

Pupils of today must become equipped to meet the challenges that will face them in the future. The use of the computer as a "problem solving" tool offers excellent opportunities for the development of thinking skills that will carry over into adult life. Moursund (1981b) describes the computer as a "brain extender" that has the capacity to supplement mental functions of humans in useful ways. In other words, the computer greatly increases our ability to perform calculations and to store and retrieve information.

Problem solving has been an important part of mathematics and science curricula for many years. Applications of mathematical concepts to the real world can be found in almost every current mathematics publication, including textbooks and periodicals such as the "Arithmetic Teacher" and the "Mathematics Teacher." Science courses, too, attempt to link basic scientific principles to practical applications in laboratories. Most other subjects, however, have not applied problem solving techniques to the same extent.

What the computer has to offer is its ability to process information speedily and accurately, and to do so according to a specific set of instructions, or algorithm. The type of information to be processed can vary greatly since the computer is able to process words as easily as it can numbers, and it can also draw pictures and make sounds. There is virtually no limit to the variety of problems to which the computer can be applied. Moreover, a child can be introduced to the process of solving problems with computers in the primary grades.

The following is a short list of topics for computer-based problem solving activities:

* solving mathematical problems
* balancing a chequebook
* generating metric conversions
* summarizing statistical data
* drawing graphical figures
* creating a spelling game
* composing a piece of music
* recording historical events

You may feel that a computer is hardly necessary to accomplish most of these activities, and that is quite true. What the involvement of the computer adds is the requirement of a carefully prepared plan of action in solving the problem; a haphazard approach will seldom be successful. As the student works through the problem, the process of solving it becomes the focus; the problem itself is incidental. Important, also, is the fact that the student will learn how to use computers.

The following steps describe a general procedure that can be used to solve a specific problem:

1. ANALYZE THE PROBLEM. This involves breaking the problem down into its component parts. The student will then determine the additional information and resources needed to proceed. This will likely involve consulting reference materials such as computer manuals, textbooks, and periodicals. Thus, the student's information base will be expanded.

2. DEVELOP AN ALGORITHM. Creating the procedure by which the problem will be solved is probably the most important step. It is here that the student's knowledge of the subject matter will be directly applied. Each detail of the procedure should be clearly stated. A relatively simple problem, such as calculating the area of a rectangle, could be dealt with as a single procedure. A more complex problem, like providing for a broad variety of metric conversions, could require several "sub-algorithms" to be developed by a group of students as separate "modules", and finally merged to provide a single comprehensive solution.

3. PREPARE A FLOWCHART. The advantage of a flowchart is that it provides a "picture" of the procedure to be applied. It permits the teacher to check the algorithm for accuracy at an intermediate point. If deficiencies are found, the student can be assisted in modifying the algorithm before the next step. The flowchart can be expressed either by flowcharting symbols, or by a set of

written statements which describes the algorithm in words.

4. WRITE THE PROGRAM. The flowchart must then be translated into the language of the computer. This requires a minimal understanding of a computer language by the teacher, and by the students. Teachers should enlist the aid of those students who have already developed some programming skills to assist those students experiencing difficulties. The idea of having students teach students (peer teaching) has much to offer, both for the learner and the tutor.

5. DEBUG THE PROGRAM. Removing the errors from a computer program provides the learner with another opportunity for analytical thinking. Unlike humans, who can often "fill in the blanks" when incomplete information is given, the computer makes no assumptions about what the programmer intended. Every little detail of the program must be correct. Fortunately for the programmer, most computer languages automatically identify errors in syntax. Once the syntax errors have been debugged, the computer will produce answers, right or wrong. If the program is not precisely correct, the young programmer will soon know about GIGO; Garbage In - Garbage Out.

6. DOCUMENT THE PROGRAM. Once the student and the teacher are satisfied that the program has correctly solved the problem, the student should formally "document", or describe, the program. Good documentation is critical to the future use of a computer program. Documentation can be included in the program itself by means of remarks (REMs). Many programs are also documented in a printed "manual", particularly if they are to be used by others. Modifications to a program at some future time, even by the original programmer, are much easier to carry out if appropriate documentation has been included.

These steps can be applied to solving virtually any problem in any subject area. The challenge to teachers is to identify appropriate problems and to assist their students in solving them.

LOGO

Students at the upper elementary levels, and beyond, have little difficulty in learning enough of the BASIC language to solve complex problems. This is not the case with primary students, however, since the degree of abstraction required to program the computer is generally beyond their developmental level. In an effort to permit primary students to solve meaningful problems on the computer, a rather different computer language, LOGO, has been developed at the Massachusetts Institute of Technology (MIT) by Seymour Papert and his associates (Papert, 1980). They suggest that even before a child enters kindergarten, he or she can program a computer to perform meaningful tasks and, thus, solve problems.

The initial focus of the group at MIT was on the use of a computerized "turtle", a toy on wheels that could move about a large sheet of paper on command and draw geometrical shapes by means of an attached pen. A square, for example, would result when the turtle was instructed to do a series of four equal forward movements interrupted by three right-angle turns. As the child progressed, more and more complex figures would be drawn. Their research with many young children has indicated that "turtlegraphics", as they called the procedure, was easily understood by most primary school children.

They then took their idea one step farther and developed LOGO as a computer language, so that turtlegraphics could be performed directly on a computer screen. On the screen, the student is presented with an "arrowhead" in place of the turtle. The arrowhead indicates both the position of the turtle and the direction in which it will move. Following, are three examples of LOGO programs and the figures they will generate on the computer screen. As you can see, the commands simply direct the movement of the arrowhead on the screen and the figure is drawn accordingly. Papert suggests that the child's experiences with LOGO encourages him or her to "think about thinking" at a much earlier age.

While very complex figures can be created using LOGO, it can also perform complex calculations and handle strings of words, much as BASIC and other computer languages. LOGO is now available for use on several microcomputers. You will be surprised at how easy it is to learn and use.

WORD-PROCESSING

For several years, business and government offices have been using computers, rather than typewriters, for many applications that require repeated use of the same document. For example, lengthy letters and reports which must be drafted and redrafted can be prepared on a computer in a fraction of the time. Also, most newspaper articles are now composed by the reporter sitting at a "video display terminal" (VDT) and entering the article directly into the computer. When the entry is complete, the computer automatically checks the reporter's spelling and then the article is immediately available for insertion in the next edition of the paper. WORD-PROCESSING is the term used to describe this growing use of computers. Word-processing can greatly reduce the time required to prepare documents while improving the appearance of the finished product.

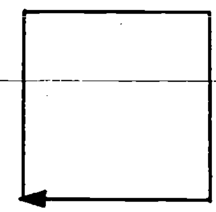
Word-processing uses the computer's ability to store information (words) in its memory (RAM). Once it has been entered, the information can be modified by insertions or deletions while the remainder of the information is automatically adjusted to accept the changes. The edited version can then be output onto a printer in the desired format. It is also possible to save the information on a diskette or cassette for future use. This book, for example, was prepared on a word-processor.

There are several specialized word-processors available. These are advertised for use in business offices and they cost from about $6,000 to over $100,000, depending on the size and complexity of the system. However, anyone who has a microcomputer available can usually convert it

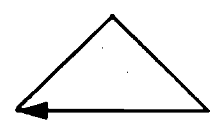
THREE SIMPLE LOGO PROGRAMS

The Program | The Result

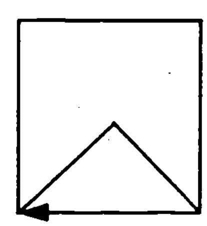
```
SQUARE              [This is the name
                     of the procedure]
 FORWARD 100        [Screen Units]
 RIGHT    90        [Degrees of Arc]
 FORWARD 100
 RIGHT    90
 FORWARD 100
 RIGHT    90
 FORWARD 100
END
```



```
ISOSCELES
 RIGHT    45
 FORWARD  70.7
 RIGHT    90
 FORWARD  70.7
 RIGHT   135
 FORWARD 100
END
```



```
COMBINE
 SQUARE             [Note that this
 RIGHT    90         program is a
 ISOSCELES           combination of
END                  the first two.]
```



into a word-processor for the cost of a software package; from $75 to $250 depending on the package selected. Therefore, any school that has a microcomputer can provide word-processing experiences for its students.

Teachers of business education are aware of word-processors and are now introducing their students to them. Other teachers, particularly of the language arts and social studies, should also recognize the potential benefits of word-processing for their students. Students at both elementary and secondary levels, who reluctantly produce essays and reports in illegible handwriting, are very often capable of producing much better work on a word-processor.

Many elementary teachers use word-processing as the means of introducing their students to the computer. A majority of word-processors are even easier to use than typewriters. Most primary level students, and virtually all intermediate and higher students, have little difficulty in acquiring the necessary skills.

THE ELECTRONIC BLACKBOARD

The computer's ability to store and retrieve information can be used with a group of students or an entire class. With appropriate cable connections, a computer's output can be fed into one or more television sets at once to, provide the teacher with an ELECTRONIC BLACKBOARD. Print and graphic materials can be prepared in advance, stored on a diskette, and then presented as many times as necessary. Moreover, the materials can be quickly modified and updated.

Programming for the electronic blackboard is relatively easy; it is simply a matter of entering the textual material into a series of PRINT statements. The presentation sequence is then controlled by a routine which permits the teacher to advance to the next step in the sequence by simply touching a key on the computer's keyboard. With a printer attached to the computer notes, identical to those appearing on the screen, can be printed to provide copies for the class. To make it even simpler, software packages are available that provide "shells" into which the teacher can enter the information to be presented. The program will then generate large characters that can be more easily seen by the viewers. Graphical illustrations can also be output onto the screen as part of the sequence. The content of virtually any subject can be presented in this way.

An alternative for teachers of languages, in working through specific examples of writing with their classes, is to use a word-processor as an electronic blackboard. For example, a faulty composition can be displayed, and then gradually improved with the participation of the entire class. The teacher, or one of the students, can easily make the appropriate changes to the text as the discussion proceeds. The corrected version can then be printed and distributed to the class.

The classroom of the future will very likely have large display panels to present output from computers and videodiscs. The technology is already available to accomplish this, but it is still very expensive.

CLASSROOM TESTING

Computers have been used to score and analyze educational tests for over 20 years. School districts have usually contracted with various testing services to administer, score, and report on the results of achievement testing in the schools. These testing services have made an important contribution by providing schools with useful information on the progress of their pupils. There are, however, two major problems associated with the use of testing services for classroom purposes: the first is that you usually are obliged to use a "standardized" test which might not adequately cover the objectives of your course; and the second is the necessary delay of at least a week in getting your test results back from the testing service.

With a microcomputer it is possible to administer your own tests and receive the results on the day the test was administered. This can be done either by having each student sit at the computer and answer the questions "on-line", or by having the class respond to the test on computer cards which can be quickly entered into the computer through a card reader for scoring and analysis. A growing number of secondary schools have a card reader attached to a microcomputer, with programs for scoring and analyzing classroom tests.

On-line testing has the advantage of being able to provide both the student and the teacher with immediate feedback on the student's performance. This type of testing is not difficult to program, but it is rather time consuming. However, help is available in the form of software packages that provide "program shells" into which the teacher can enter his or her own test items. This type of testing can be particularly useful in support of the mastery learning approach to instruction.

Microcomputers are being used to store "item banks" in various subject areas and grade levels. These may be purchased on diskettes complete with items and the programs necessary for selecting the items, printing the test, and modifying the items. Useful items may be retained for future tests while faulty items can be modified or discarded, and new items added. The main advantage is the speed with which tests can be created. All the teacher need do is specify the items to be included in the test and the computer will print two versions of the test; one that can be used as the "master" for copying, and one that indicates the keyed responses for the teacher's reference. Item banks can remove much of the effort required to create classroom achievement tests and can help to improve their quality.

VOCATIONAL GUIDANCE

High school students, as they approach graduation, are faced with a bewildering array of vocational opportunities. Many, of course, determine for themselves what careers they wish to pursue and make their own plans. For the majority, however, a selection must be made from among the career possibilities available to them. This means obtaining information on careers, matching interests and abilities with a broad range of opportunities, and identifying a reasonable set of possibilities for closer consideration. This process can be carried out by reading pamphlets and then discussing the results of reading with a vocational counsellor in the school; or it can be done by direct interaction with a computer.

A number of computer-based career planning programs are available. The program used most frequently in Canada is called CHOICES, which was developed with the support of the federal government. CHOICES was originally designed to operate on large mainframe computers, but is now available for microcomputers, also. To use the program, the student sits at the computer keyboard and responds to a series of questions that gradually identifies a set of vocations that match the student's interests and abilities. When the session, which may last a half hour or more, is concluded, the student takes the printout and discusses the information with the school counsellor. Thus, computer-based career counselling offers each student an up-to-date set of vocational choices which have been "tailored" to suit his or her particular needs.

CHAPTER FIVE

A COMPUTER IN YOUR CLASSROOM

PREPARING YOURSELF

Introducing a microcomputer into your classroom requires the same careful consideration you would give to any new teaching technique. You should have a fairly clear idea of what you want to use it for, and sufficient knowledge to be able to use it effectively. This will likely require some in-service training, so that you will have the confidence to move ahead with planning and implementation.

Probably the best person to talk to is one of your fellow teachers who is already using computers effectively. If there is no one active in your own school, ask around. Most computer-using teachers are pleased to show you what they are doing and will give you many useful suggestions based on their experiences. To get started, you should attend an introductory workshop on computers in education. These are usually sponsored by the local Professional Development Committee, or the school district. You might then consider enrolling in a week-long workshop, or perhaps a credit course at a college or university.

If you follow through on these suggestions you'll be pleased with the knowledge and confidence you have gained, the contacts you have made with other teachers, and the enthusiasm you have developed for using computers in your own classroom.

ESTABLISHING OBJECTIVES AND LEARNING OUTCOMES

Long before you first bring a microcomputer through your classroom door, you should have developed a plan of action for the role you want it to play. The experience of others indicates that without such a plan the potential benefits will not likely be achieved and you will be unhappy with the results.

You should first carry out a review of the learning experiences you currently provide your pupils. You should be able to identify several topics that could be enhanced by the use of the computer. You can then formulate the general objectives of your computer-based program. At this point it is probably wise to have more objectives in mind than you will ultimately use. Use your imagination and creativity, and don't be limited by the applications you have seen; develop some of your own. Any of the techniques discussed in Chapter Four can be adapted to meet your particular needs.

You should then specify, as clearly as possible, the learning outcomes you would expect to observe if the application is successful. Doing this will help you plan the learning activities for your class. It will also provide the basis for evaluating the achievement of your pupils and, therefore, the success of your application. Your lists of objectives and expected outcomes will, in addition, help to specify the hardware and software you will require.

ACQUIRING HARDWARE

Most secondary schools already have one or more microcomputers. These are most frequently used for computer science courses and administrative applications, but more and more are finding their way into other classrooms. There are relatively fewer microcomputers in the elementary schools, and seldom is there more than one computer per school. This means that you will either have to share an existing facility with other teachers, or plan to obtain one for yourself. For beginners, it is highly desirable to work with someone who is already involved in using computers. However, if your school does not yet have a microcomputer you might consider organizing an effort to acquire one. The following should help you to develop a plan of action.

Many teachers, with a high personal interest in computers, have purchased their own equipment and made it available to their pupils. However, since a microcomputer system can cost anywhere from $600 to $6000, it is unlikely you will want to buy one with funds from your own savings account. This means that you may have to convince your fellow teachers, your principal, and perhaps the central school administration, of the benefits of having a microcomputer in your school.

If you have carefully stated your goals and objectives, they should help in illustrating your intent to others. This, coupled with the prevailing high interest in computers, will help to justify the purchase. And, when you gain the support of one or more colleagues who are also interested in using computers, you will further strengthen your position. Once you let your interests be known, you will likely discover several fellow teachers who are willing to become involved.

The next step is to consult a local expert on the capabilities and costs of the microcomputer systems that are available. These include models manufactured by Apple, Atari, Commodore, IBM, Monroe-Litton, Radio Shack, and Texas Instruments, to name a few of the more popular systems. Some computer stores carry the products of only one manufacturer while others carry several. With your set of objectives in hand you should request that each of several vendors provide you with a written quotation. The quotation should include specifications of the equipment to be purchased, the costs, warranties, servicing arrangements, manuals, textbooks, and software support. Obtain as many of these quotations as you can, since there can be considerable variation in costs, even within the same product line. Then, if possible, sit down with someone who has some experience in using computers, together with your interested colleagues, and place the quotations in an order of preference. Cost should not be the sole basis for your selection; the availability of high quality software is equally important.

If you have done your homework well, you should have a clear statement of the costs involved. A direct appeal to the school district may be sufficient to obtain the funds you need. However, if support from the district is not available, you still have an alternative. Many parent and teacher groups have successfully raised funds to purchase computer equipment, particularly in the elementary schools. At the secondary level, the students, with teacher support, are capable of raising funds with car washes, bottle drives, and the like. The amount to aim for, initially, is from $2000 to $3000. This should provide you with the microcomputer, one disk drive, and a color TV or MONITOR. A printer will cost an additional $500 to $1500, depending on the quality of output you want. Additional costs to bear in mind include: blank diskettes (approximately $2.50 each), paper for the printer, maintenance and servicing, and the costs of software and courseware.

ACQUIRING SOFTWARE AND COURSEWARE

Once you have resolved the difficulties associated with getting the hardware you will require, the matter of acquiring useful software and courseware remains. There are several sources to consider, the most convenient of which is a fellow teacher who is already using programs that are appropriate to what you have in mind. Failing that, you will have to do some searching on your own.

In British Columbia, the Provincial Educational Media Centre (PEMC) has the responsibility to acquire and distribute software, at cost, to the schools of the province. If your school does not have a list of software currently available from this source, you should write to the PEMC, at 7351 Elmbridge Way, Richmond, B.C., V6X 1B8, to obtain a copy. Most other provinces have a similar service available to teachers.

Another source of information about microcomputer software is the "JEM Reference Manual", (Forman, Crawford, & Tennant, 1981). This document contains a courseware index sub-divided by subject, an extensive set of reproductions of publisher's catalogues, a list of publishers and distributors of courseware, a list of books on computers, a list of computer magazines and periodicals, and a list of hardware accessories. It should be noted that the materials described in the JEM Manual are largely specific to the Apple II Plus microcomputer. The JEM Manual is available from: JEM Research, Discovery Park, University of Victoria, P.O. Box 1700, Victoria, V8W 2Y2.

Software and courseware information is also available from the Computer Using Educators of B.C. (CUEBC), a Provincial Specialist Association (PSA) of the B.C. Teachers' Federation. Information about the services available to teachers from CUEBC may be obtained from the BCTF offices in Vancouver.

Computer stores are also important sources of software. In addition to the packages they have on hand, most computer stores have catalogues that describe the software and courseware available for the computers they sell.

The cost of microcomputer software and courseware varies greatly; from the price of the blank diskette on which the programs are copied for you, to $1000 and more. The age old saying, "buyer beware", applies to the purchase of software, however. One usually expects the cost of something to relate closely to its quality. However, some of the best computer software is relatively inexpensive while some of the poorest carries a rather high price tag. Most software vendors do not offer you a money-back guarantee, and you are usually obliged to buy the package before you can try it out. The reason for this, of course, is that most programs can be copied and the vendor is simply protecting his financial interests. This means, however, that you should be confident that the package will perform according to your specifications before you purchase it. If you cannot have the software on a trial basis you should talk to someone who has already used it. Most vendors will give you a list of persons who have purchased their software. The courseware also may have been evaluated and reported in some of the publications listed in the Bibliography.

At the present time, teachers in British Columbia can request a courseware evaluation through the facilities of the PEMC. Wherever possible, the PEMC will obtain programs and have them evaluated by teachers in the field. More information on this service will be found later in the section on Courseware Evaluation.

Finally, a note on copying software that has been copyrighted. Even though many software vendors "lock" their diskettes, and thus make copying difficult, the contents of most diskettes can be copied by means of specially designed copy programs, and they frequently are. Computer software is copyrighted to protect the interests of the developer in essentially the same way as are books, magazines, and other publications. Failure to observe the copyright laws can result in legal action, and such action is occurring with increasing frequency. You should be aware of this and avoid the risk of placing yourself in a difficult legal position.

SETTING UP YOUR COMPUTER FACILITY

Unlike larger computers, which must be set up in a permanent location, most microcomputers can be moved about quickly and easily by one or two people. Of course, the smoother the move the better since delicate electronic components don't respond well to rough treatment. With reasonable care, however, microcomputers travel well.

If the computer is to be shared by two or more teachers, it is desirable to have it mounted on a rubber-wheeled table. The school district's maintenance shop could probably build one for you at a reasonable cost. As long as you don't have to move the computer between floors, the table can be rolled from one classroom to another in a matter of minutes. If it is well designed, the mobile table can serve as the "learning station" itself, thus avoiding the need for a special location in each room. The width of the table should permit it to move easily through classroom doors, and the length should be sufficient to contain all of the computer components with a small area on both sides of the computer keyboard for manuals and notebooks. A top surface of about 60cm by 120cm (2' by 4') would be adequate for most microcomputer systems. If you intend to have a more permanent setup, regular tables will be sufficient.

It is probably best to have the computer at the rear of the classroom. This will minimize disruptions to the class, while permitting you to monitor student activity at the computer. There should be enough floor space to permit up to three pupils to sit at the computer at one time.

Many schools have an area designated for computers with the expectation that most student use will take place there. This can vary from a small room with a single computer, to an area in the library, to a specially designed computer studies laboratory with several systems installed. If a single facility is to be shared among several teachers it will be important to set up an access schedule that is fair to all. Ideally, a teacher should have regular access to three or four computers in the classroom, however, most teachers will have irregular access to one system.

It is very important at the outset to establish rules and regulations regarding the use of the computer. Most students will follow them to the letter as long as they are clearly stated and consistently maintained. Care in the use of the equipment is essential and the most effective means of disciplining those who break the rules is to deny them the privilege of using the computer for a specified time. If access to the computer is to be permitted outside of regular school hours, arrangements should be made to ensure that a responsible adult is in attendance; often parents are willing to assist in this.

This brings us to consider the security of your computer. As we all know, schools are frequent victims of vandalism and theft. To reduce the possibility of theft, every piece of equipment should be clearly identified with permanent markings. An inventory of hardware and software should be maintained, including model and serial numbers, and replacement costs; the computer can be used to do this. You should also confirm that the computer equipment is insured for theft and damage.

Most microcomputers are very reliable when used properly. However, they do "go down" from time to time for a variety of reasons. This means that you will be without your system for the time required to repair it. If there isn't a "backup" system available in your school, the computer store may be able to lend you one.

The costs of repairing a computer system can be considerable, with the labor charge usually much higher than that for replaced components. After the warranty period expires, usually in 90 days, most computer stores will offer a "service contract" that covers virtually all service costs. These contracts, however, can be expensive so you should consider the advantages and disadvantages of purchasing one. Alternatively, your school district may already have a service facility available to you. If there are several computers in the school, it is probably wise to identify someone to coordinate the maintenance requirements.

PLANNING AND PRESENTING YOUR COMPUTER-BASED ACTIVITY

You now want to make sure the software you plan to use will do what you want it to. The only way to be sure is to try out the entire program yourself under conditions similar to those your students will experience; in other words, a "dry run." This will help you to evaluate the quality of the software and to estimate the amount of time required to complete the program. If you are satisfied with the results, you can proceed with the implementation. A word to the wise; don't be too ambitious, a few modest successes at the outset are preferable to a major undertaking that fails.

If your pupils have had no previous formal experience with computers, you will have to make the necessary introductions. Each pupil should have a clear understanding of how to handle diskettes, how to switch the system on, how to use the keyboard and other input/output devices such as game paddles and printers, and how to shut the system down. They should also know that the teacher must be consulted whenever a difficulty arises, and not to attempt to "fix" the problem themselves.

What you do next depends very largely on the activity you have in mind. If your plan is to use a courseware package, such as a drill and practice routine or a tutorial, it is important to discuss with your pupils how the computer activity relates to what they have been studying, and how they are to use the program. Then you will have to schedule each pupil's time on the computer. While we normally think of having one student on the computer at a time, for some activities it may be more effective to have two pupils working together, since they can assist each other in understanding what is being presented. Whichever approach you use, your pupils should be given sufficient time to complete the learning task. You will want to monitor the progress of each pupil to ensure that time spent on the computer is being used effectively.

If the courseware has an achievement test built into it, you can use the results to evaluate the effectiveness of the activity. However, if a test is not included, you should consider preparing one yourself, just as you would for any regular unit of study. Wherever possible, you should follow the computer activity with class discussions aimed at integrating it with the broader unit of study. Finally, comments on the activity by the class can be very helpful in planning future improvements.

If you plan to use a word-processor, it will first be necessary to instruct the class in the concepts and techniques involved. Most pupils, from grades two or three, have little difficulty in learning how to use a word-processor. Once pupils have learned the few commands necessary to operate it, they can proceed with relatively little supervision. Formal typing skills are not necessary at the outset, since even the youngest children quickly acquire a reasonable competency with the keyboard. Planning for word-processing activities differs little from that required for any writing exercise. When the initial draft of an essay has been entered, saved on diskette, and printed, it is then simply a matter of working through successive drafts to the finished product.

If you plan to introduce your pupils to problem solving via the computer, it will be necessary to begin with some preliminary instruction in computer programming. Whether you use BASIC or LOGO, or another language, begin with a very few elementary operations and start your pupils on very simple problems. As programming skills develop, the problems can become more complex. It is possible that some of your pupils have already developed skills in programming, perhaps somewhat beyond your own. Don't feel threatened by this, but rather, take advantage of it by having these pupils assist you in teaching others.

Scheduling time on the computer requires that you be systematic and consistent. It is probably best, at the outset, to assign equal time slots of 15 or 20 minutes to each pupil on a regular basis. A copy of the schedule should be posted near the computer, and you should keep a backup copy yourself. You will probably find that the schedule is carefully observed. The alternative is to let the pupils schedule themselves. This is something that older students can do as long as the conditions are carefully laid out. In either case you will want to check the schedule regularly to ensure that every pupil gets his or her fair share of computer time.

EVALUATING COURSEWARE

It has already been noted that the quality of courseware available at this time varies greatly. Some authorities have estimated that at least two-thirds of the courseware on the market is not worth using, and some users, perhaps with higher expectations, place this closer to 90%. Regardless of which figure is the more accurate, the conclusion is that courseware should not be purchased without assurances that it will serve the purposes for which it is intended. It is important, therefore, that courseware be evaluated by those who actually use it, and that the results of these evaluations be made available to other users.

A number of educational authorities have established courseware evaluation services to assist teachers. In British Columbia, the Provincial Educational Media Centre (PEMC), provides a Courseware Evaluation Service in parallel with its responsibility to acquire and distribute high quality courseware. The PEMC involves computer-using teachers throughout the province in field-testing and evaluating computer-based materials. As many as 100 teachers have volunteered to take part in the evaluation process; you can contact the PEMC to obtain the names of evaluators near you. Courseware is evaluated according to a standard "PEMC Microware Specifications Form" which can be seen on the pages following. An "Evaluator's Guide" is available to assist the evaluator in using the Form. Both the Form and the Guide can be obtained from the PEMC.

The results of these courseware evaluations are published regularly by the PEMC in "Evaluations: Microware", which is distributed to computer-using teachers and school district Resource Centres. You can be placed on the mailing list by contacting the PEMC directly.

On the basis of the evaluations submitted by the panel members, one of the following decisions may be made:

1. The package is not recommended for purchase;

2. The package is recommended for purchase if the producer makes changes;

3. The package is recommended for purchase;

4. Where the package is of particularly high quality, the PEMC will attempt to acquire the rights to copy and distribute it as supplementary to the provincial curriculum;

5. The package may be recommended to the Curriculum Branch of the Ministry of Education to be considered for authorization or prescription.

If you study the Microware Specifications Form carefully, you should be able to recognize the criteria against which courseware is to be evaluated. The following is a summary of the main points that should be included in an evaluation:

1. A description of the content, method of presentation, and equipment required;

2. An indication of the target population;

3. A statement of instructional objectives;

4. An indication of prerequisite skills;

5. A description of supplementary materials that accompany the courseware;

6. Ratings of various technical components as in items 1 to 21;

7. A statement of the overall effectiveness of the courseware;

8. A recommendation on the use of the courseware by others.

Perhaps the most frequent criticism of courseware is that it does not apply the principles of learning that would be used by teachers in dealing with the same content. This criticism reflects the fact that most courseware on the market is developed by programmers, and not teachers. It seems obvious, therefore, that improvements in courseware will occur only when teachers become directly involved in its development. It must be recognized, however, that few teachers have the time, or the interest, to become skilled programmers. The alternative is to have teachers develop the content and presentation strategies, and then work with professional programmers to prepare the courseware. Indeed, if teachers do not participate in the development of courseware, it is unlikely that substantial improvements in its quality will take place. In other words, if computers are to find a permanent place in school classrooms, teachers will have to be involved in the production of courseware.

Emc **MICROWARE SPECIFICATIONS FORM** VERSION 1.2

In order that the Provincial Educational Media Centre may maintain a trusting relationship with courseware suppliers, we ask that you do not violate copyright in anyway. Your signature is required to indicate this on page 4 of this form.

ESCRIPTION

:kage Title	Version
ıducer	Address
ıtributor	Cost
bject Area	Grade/Ability Level
ecific Topic	Dewey Decimal
ırs Subject Headings	

DIUM OF TRANSFER:	REQUIRED HARDWARE (p. 7)	REQUIRED SOFTWARE (p. 7)	COMPONENTS:
Tape Cassette	Options:	Requirements:	Complete Package
ROM Cartridge			Single Program
5" Flex Disc			Integrated Program Series Component
8" Flex Disc			
DOS			Other

EVELOPER'S RATIONALE

STRUCTIONAL PURPOSE:	INSTRUCTIONAL TECHNIQUES:		PROGRAM LISTING AND ALTERATION:
Remediation	Drill and Practice	Simulation	Can Teacher Alter?
Standard Instruction	Tutorial	Problem Solving	Can Back-up Be sent?
Enrichment	Informational Retrieval	Learning Management	Can Teacher Copy?
	Game	Utility	
	Other		

ICUMENTATION AVAILABLE:

(CIRCLE ALL THAT ARE AVAILABLE IN THE COMPUTER PROGRAM (P) OR IN THE SUPPLEMENTARY MATERIALS (S

'	S	Suggested Grade/Ability Levels	P	S	Pre-test	P	S	Teacher's Information
'	S	Prerequisite Skills or Activities	P	S	Post-test	P	S	Resource Reference Informatio
'	S	Program Operating Instructions	P	S	Student Worksheets	P	S	Follow-up Activities
'	S	Instructional Objectives	P	S	Student Instruction	P	S	Relationship to Standard Textbooks
'	S	Sample Program Output	P	S	Other			

RODUCT DEVELOPMENT

ho Developed?	Who Evaluated?
story of Revision	

INSTRUCTIONAL OBJECTIVES: ☐ Stated ☐ Inferred

INSTRUCTIONAL PREREQUISITES: ☐ Stated ☐ Inferred

DESCRIBE PACKAGE CONTENT AND STRUCTURE:

	STRONGLY AGREE	AGREE	DISAGREE	STRONGLY DISAGREE	NOT APPLICABLE	IMPORTANCE (HIGH)	IMPORTANCE (LOW)
CONTENT							
INSTRUCTIONAL QUALITY							
TECHNICAL QUALITY							

RATING: Check the square [√] which best reflects your judgement. (Use the space following each item for comments.)

IMPORTANCE: Check the square [√] which reflects your judgement of the relative importance of the item in this evaluation. Note major weaknesses and strengths in 23 and 24.

☐ Check this box if this evaluation is based partly on your observation of student use of this package.

	EVALUATOR'S GUIDE PAGE REFERENCE
1 The content is accurate.	12
2 The content has educational value	12
3 The content presents a balanced view of any social consideration	12
4 The purpose of the package is well-defined.	12
5 The package achieves its defined purpose	13
6 Presentation of content is clear and logical.	13
7 The level of difficulty is appropriate for the target audience.	13
8 Graphics/colour/sound are used for appropriate instructional reasons.	14
9 Use of the package is motivational.	14
10 The package effectively stimulates student creativity.	14
11 Feedback on student responses is effectively employed.	15
12 The learner controls the rate and sequence of presentation/review.	15
13 Instruction is integrated with previous student experience.	16
14 Learning is generizable to an appropriate range of situations.	16
15 The user support materials are comprehensive.	16
16 The user support materials are effective.	17
17 Information displays are effective.	18
18 Intended users can easily and independantly operate the program.	19
19 Teachers can easily employ the package.	20
20 The program appropriately uses relevant computer capabilities.	20
21 The program is reliable in normal use.	21

22. CHECK ONE ONLY

☐ I would use or recommend use of this package with little or no change.

☐ I would use or recommend use of this package only if certain changes were made.

☐ I would not use or recommend this package.

☐ I would recommend this package to be considered for authorization/prescription.

23. Describe the major strengths of the package. (Evaluator's Guide Page 21)

24. Describe the major weaknesses of the package. (Evaluator's Guide, Page 21)

25. Describe the potential use of the package in classroom settings. (Evaluator's Guide Page 22)

Evaluator's Name (Print)

Address (School)

Phone Number

Date

I agree to allow the Provincial Educational Media Centre to list my name and address with Product Information related to this evaluation and confirm that no attempt was made to copy or modify the program or accompanying documentation.

Evaluator's Signature

As an evaluator you may be contacted by the courseware producer. Please make a copy of the evaluation for your file so that you can provide constructive criticism of these programs and (or) documentation.

Return to: Provincial Educational Media Centre, 7351 Elmbridge Way, Richmond, B.C., V6X 1B8

SOME ADDITIONAL THOUGHTS

Computers are fun, there can be no doubt about that, but they seem to have much greater attraction for boys than for girls. The reasons for this are not entirely clear, although the war-like nature of most computer games may be part of the explanation. Teachers should be aware of this and encourage girls to become more involved with computers in ways that are meaningful for them. This would involve the assignment of projects that appeal to the specific interests of girls. An initial focus on word-processing, as an aid to written composition, could demonstrate the advantages of computer applications to girls. Or, you might use a problem solving approach which allows pupils to select from a variety of problems. You should also inform your pupils that women comprise a large proportion of computer professionals. Careers in the computer field should be among those considered by girls in their vocational planning. Inviting a woman who works with computers to describe her job to your class could reinforce the importance of a career in computers.

We are regularly informed by the news media of the possibility of health hazards associated with sitting in front of a CRT display for lengthy periods. The evidence at this time neither confirms nor denies whether CRTs do emit sufficient radiation to influence one's health. Until the matter is resolved, caution and common sense should be your guide. Make sure that your TVs and monitors carry the Canadian Standards Association (CSA) label of approval; no CRT can bear this label that does not conform to the current CSA criteria for maximum radiation. If the label is not in evidence, you should write to the CSA, including model numbers and all other relevant details, for confirmation of the CRT's status. In general, however, a child should not sit in front of a CRT for more than one half hour at a time. If you use this as your rule of thumb, the effects of any radiation should be minimal.

You should now have a reasonable overview of the role that computers can play in your classroom. However, you should also recognize that this is just the beginning for you, and for the field of education generally. What happens from here on depends very largely on you and your colleagues who are willing to devote sufficient time and effort to improving the effectiveness of computer applications in education. If classroom teachers do not get directly involved in this process, they will be passed by. Unlike most other educational innovations of the past, computers are here to stay. The major question at this time is whether we, as teachers, can take advantage of what computers have to offer to our schools.

CHAPTER SIX

THE ADMINISTRATOR AND THE COMPUTER

This brief chapter is directed at those principals and vice-principals who have had little or no experience with computers. Teachers, however, shouldn't stop reading for that reason since there might be a few points of interest for you, too. The fact is that if school administrators are not "sold" on a new idea it is most unlikely that it will be implemented. This, then, is an attempt to show administrators that they, too, can benefit from having microcomputers in their schools.

Many school districts have been using computers for administrative purposes for 15 to 20 years. The larger districts tend to purchase or lease their own computing equipment while smaller districts most often use commercial services. Some districts have provided computer services to their secondary schools via terminals to the central computer, but elementary schools have seldom had access to computers. The arrival of the microcomputer, of course, has changed all that.

A microcomputer with one or two disk drives and a printer attached offers a broad range of applications to assist in the administration of even the smallest schools. Many useful administrative program packages are available for most makes of microcomputer. While the initial costs of purchasing the hardware and software are substantial ($4000 to $6000), the benefits are such that it is possible to recover the outlay, through increased productivity, within two to five years.

Word-processing will permit your secretaries to become much more efficient in communicating with parents, ordering supplies, and preparing many routine documents. A series of forms and form letters can be prepared once, and then modified as required for each specific purpose. The saving in time and effort can be substantial.

A student record file will give you immediate access to the current status of every pupil in the school, individually, by grade, by classroom, by subject, or by any other meaningful category you may choose. Changes in status can be updated easily and new lists prepared regularly without the secretary having to retype every list. In addition, labels for mailing or identification can be quickly prepared using the student file.

Attendance records can be incorporated as part of the student record file with daily, weekly, and monthly summaries available on request. Several combined student record and attendance program packages are available. They cost from about $300 and up to around $3000. While it is possible to enter attendance data into the computer via the keyboard, it is much faster to use computer cards and a card reader. Each elementary classroom teacher, or each secondary homeroom teacher is provided with a set of cards for the pupils in that class. At each registration the cards of pupils absent are pulled from the set and sent to the office for processing. The cards are then returned to the teacher for the next registration. The teacher receives an attendance summary for report cards and a final year-end tabulation which can be used as the official attendance record. The parents of pupils who are absent more than a specified number of days can be sent a "personalized" form letter, which includes the pupil's record, informing them of the unsatisfactory attendance, and the computer will do this automatically. All this, and the teacher has only to select the appropriate cards from the set and send them to the office.

Up-to-date inventories of textbooks, library holdings, equipment, and supplies are always difficult to maintain. Several general administrative software packages include an inventory feature. It is also possible to purchase specially designed inventory programs for a variety of purposes. Updating the inventories on the computer and printing new lists can usually be done by a secretary.

Accounting procedures can also be done on your computer. There are a number of accounting programs available, which cost anywhere from $100 to $1000. One of the most successful microcomputer programs yet written, "Visicalc", can be easily used for keeping the school's accounts. It can also be used for planning budgets because it permits you to change values and then it immediately calculates the effects of the changes on the overall budget. Visicalc has been programmed for most microcomputers and costs about $225.

The creation of a master timetable is a major task for secondary school administrators. Many schools use the services of a commercial computer firm to develop their timetables, and they pay a considerable amount for the service. There are several scheduling packages available for microcomputers, the more sophisticated of which will take student course requests from an "arena loading", generate a "conflict matrix", and ultimately produce the master timetable.

These are among the more useful applications of microcomputers for school administrators, and others are being developed. As an administrator, if you haven't already done so, you should discuss the effectiveness of these administrative applications with administrators who are now using them. You can see exactly how they are using the computer, and will benefit from their experience.

Finally, school administrators have a key role to play in acquiring computer equipment for their schools and in arranging in-service training for their teachers. Leadership in computer education is essential to the introduction of computers into our schools.

BIBLIOGRAPHY

Abrahams, J. R., & Douglas, J. A. An Introduction to BASIC Programming for Small Computers. Toronto: Gage, 1983.

Bleackley, B., & LaPrairie, J. Entering the Computer Age. Agincourt: The Book Society of Canada, 1982.

Crawford, T. BASIC Computing: A Complete Course. Toronto: McGraw-Hill Ryerson, 1981.

Doerr, C. Microcomputers and the 3 R's: A Guide for Teachers. Rochelle Park, NJ.: Hayden Book Co., 1979.

Eisele, J. E. Computers in the Schools: Now That We Have Them ...? Educational Technology, 1981, October.

Forman, D. Instructional Use of Microcomputers: A Report on B.C.'s Pilot Project. Victoria, B.C.: Ministry of Education, 1981.

Forman, D., Crawford, S., & Tennant, R. Reference Manual for the Instructional Use of Microcomputers. Victoria, B.C.: JEM Research, 1981.

Gagné, R. M., Wager, W., & Rojas, A. Planning and Authoring Computer Assisted Instruction Lessons. Educational Technology, 1981, 21(9), 17-26.

Harper, D. O., & Stewart, J. H. Run: Computer Education. Monterey, CA: Brooks/Cole, 1983.

Hungate, H. Computers in the Kindergarten. The Computing Teacher, 1982, January, 15-18.

Johnson, D. C., Anderson, R. E., Hansen, T. P., & Klassen, D. L. Computer Literacy - What Is It? The Mathematics Teacher, 1980, 73(2), 91-96.

Luehrmann, A. Computer Literacy - What Should it Be? The Mathematics Teacher, 1981, 74(9), 682-686.

Minnesota Educational Computing Consortium. Beginning Applesoft BASIC. St. Paul, MN: MECC, 1980.

Moursund, D. Teacher's Guide to Computers in the Elementary School. Eugene, OR: International Council for Computers in Education, 1980a.

Moursund, D. School Administrator's Introduction to Instructional Use of Computers. Eugene, OR: International Council for Computers in Education, 1980b.

Moursund, D. (Ed.) Topics: Computer Education for Elementary and Secondary Schools. New York: Association for Computing Machinery, 1981a.

Moursund, D. Introduction to Computers in Education for Elementary and Middle School Teachers. Eugene, OR: International Council for Computers in Education, 1981b.

Moursund, D. Precollege Computer Literacy: A Personal Computing Approach. Eugene, OR: International Council for Computers in Education 1981c.

Murphy, E. J. Developing Computer Literacy in K-12 Education. The Computing Teacher, 1981, 9(3), 43-48.

Nazzaro, J. N. Computer Connections: for Gifted Children and Youth. Reston, VA: The Council for Exceptional Children, 1981.

Northwest Regional Educational Laboratory. Evaluator's Guide for Microcomputer-based Instructional Packages. Portland, OR: NWREL, (Undated). {Available from the Provincial Educational Media Centre, Richmond, B.C.}

Open Learning Institute. Introduction to Personal Computing. Richmond, B.C.: OLI, 1981.

Papert, S. Mindstorms: Children, Computers and Powerful Ideas. New York: Basic Books, 1980.

Phipps, J. The Electronic Classroom. Toronto: Canadian Education Association, 1982.

Poole, L. Apple II User's Guide. Berkeley, CA: Osborne/McGraw-Hill, 1981.

Provincial Educational Media Centre. Evaluations: Microware. Richmond, B.C.: PEMC, 1982.

Ragsdale, R. G. Computers in the Schools: A Guide for Planning. Toronto: OISE Press, 1982.

Rogers, J. B. An Introduction to Computers and Computing. Eugene, OR: International Council for Computers in Education, 1980.

Squire, E. The Computer: An Everyday Machine. Don Mills, Ont.: Addison-Wesley, 1972.

The Computer Moves In. TIME, January 3, 1983.

Taylor, R. P. (Ed.) The Computer in the School: Tutor, Tool, Tutee. New York: Teachers College Press, 1980.

Vance, J. H. Mathematical Problem Solving: A Resource for Elementary Teachers. Victoria: B.C. Ministry of Education, 1981.

SELECTED PERIODICALS

ADCIS Newsletter,
Association for the Development of
Computer-based Instructional Systems,
Computer Center,
Western Washington State University,
Bellingham, WA 98225

AEDS Newsletter,
Association for Educational Data Systems,
1201 Sixteenth Street, NW,
Washington, DC 20036

Alberta Printout,
The Alberta Society for Computers in Education,
P.O. Box 1796,
Edmonton, Alberta T5J 2P2

Byte,
Box 590,
Martinsville, NJ 08836

Classroom Computer News,
P.O. Box 266,
Cambridge, MA 02138

Compute,
P.O. Box 5119,
Greensboro, NC 27403

Courseware Magazine,
4918 N. Millbrook, #222,
Fresno, CA 93727

Creative Computing,
P.O. Box 789-M,
Morristown, NJ 07960

CUEBC Newsletter,
Computer Using Educators of B.C.,
2235 Burrard Street,
Vancouver, B.C.

ECOO Newsletter,
Educational Computing Organization of Ontario,
252 Bloor Street West,
Toronto, Ontario M5S 1V6

Educational Computer,
P.O. Box 535,
Cupertino, CA 95015

Educational Technology,
140 Sylvan Avenue,
Englewood Cliffs, NJ 07632

Electronic Learning,
Scholastic (Canada),
Newkirk Road,
Richmond Hill, Ontario L4C 3G5

Mathematics Teacher,
National Council of Teachers of Mathematics,
1906 Association Drive,
Reston, VA 22091

MicroSIFT News,
Northwest Regional Educational Laboratory,
300 SW Sixth Avenue,
Portland, OR 97204

Pipeline,
Conduit,
P.O. Box 388,
Iowa City, Iowa 52240

SIGCUE Bulletin (Computer Uses in Education),
Association for Computing Machinery,
1133 Avenue of the Americas,
New York, NY 10036

The Computing Teacher,
Eastern Oregon State College,
LaGrande, OR 97850

USERS Newsletter,
Minnesota Educational Computing Consortium,
2520 Broadway Drive,
St. Paul, MN 55113

GLOSSARY OF COMPUTER TERMS

ALGORITHM. A series of logical steps leading to the solution of a problem.

APL. A Programming Language; a computer language, available on some microcomputers, which is particularly useful for problem solving.

ARITHMETIC/LOGIC UNIT. That part of the central processing unit which carries out the computational operations of the computer.

AUTHORING. The act of creating educational software for presentation by computers.

AUTHORING LANGUAGE. A computer language, such as PILOT, TUTOR, and NATAL, specially designed for authoring.

BASIC. Beginners All-purpose Symbolic Instruction Code. The programming language used most frequently by microcomputers.

BITs. BInary digiTs, (1's or 0's), the basis upon which numbers and characters are coded and stored in the memory of a computer.

BUG. An error in a computer program.

BYTE. Eight (8) bits, the number of binary digits required to store one character in the memory of a computer.

CAI. Computer Assisted Instruction, one of several terms that refer to the use of a computer in teaching and learning.

CARD READER. An input unit that enters data on punched or marked cards into a computer.

CASSETTE. An electromagnetic storage medium, identical to that used to play music, upon which computer data may be stored for an indefinite time.

CASSETTE DECK. An input/output unit that reads data from and stores data on a cassette.

CATHODE RAY TUBE. An output display unit; a CRT; a TV screen.

CENTRAL PROCESSING UNIT. See CPU.

CHIP. Large scale "integrated circuits" often containing thousands of electronic components on a single silicon wafer.

COMPUTER. The general term for a programmable electronic device that carries out numerical calculations and character manipulations at high speed. "Mainframe computers" are the largest and fastest, usually costing several million dollars. "Minicomputers" are of medium size and speed, costing hundreds of thousands of dollars. "Microcomputers" are the smallest and slowest, but they cost only a few hundred dollars.

COMPUTER LANGUAGE. The means whereby human programmers instruct computers to perform their tasks. BASIC is the computer language available on most microcomputers. Other computer languages include FORTRAN, PASCAL, and LOGO.

COURSEWARE. Computer programs specifically designed to instruct learners; educational software.

CPU. The Central Processing Unit of a computer, which directs all of the computer's activity; the "brain" of a computer.

CRT. See Cathode Ray Tube.

CURSOR. A symbol, often a flashing light patch, that moves about a CRT display to indicate where the next character will appear.

DATA. Information which is input to, processed by, or output from a computer.

DEBUG. The act of removing errors from a computer program.

DISKETTE. A circular electromagnetic medium upon which computer data can be stored for an indefinite period.

DISK DRIVE. An input/output unit that reads data from and stores data on a diskette.

DOCUMENTATION. A written description of the function performed by a computer program at each stage. Remarks within the program listing usually provide the necessary description.

DOS. Disk Operating System; the system program that "saves" and "loads" data to and from a disk drive.

EDITOR. A program which permits modifications to data stored in a computer.

ERROR MESSAGE. An indication from the computer that it has encountered a condition in a program that it cannot process. Often this results from the faulty use of the computer language.

FILE. A set of data stored in either the computer's memory, or on a diskette or cassette.

FIRMWARE. Computer programs that are permanently stored on "chips"; programs that remain after the power has been switched off the computer, and are immediately available when the power is switched back on, ROM.

FLOPPY DISK. Another name for a "diskette."

FLOWCHART. A graphical or verbal set of directions that outlines the "algorithm" to be programmed.

FORTRAN. FORmula TRANslation; one of several computer languages designed for scientific computing.

GAME PADDLES. Input units that permit one to control the functioning of computer programs by simply turning a knob, or pressing a button; essentially a variable resistor that can be "read" by a computer.

GRAPHICS TABLET. An input unit that permits figures to be "drawn" on a computer's CRT.

HARDCOPY. Printed output from a computer.

HARDWARE. The physical components of a computer system.

INPUT. Data entering a computer from any of several sources.

INPUT UNITS. Hardware components that enter data into the memory of a computer; a peripheral device such as a keyboard or a card reader.

INSTRUCTION. A command to a computer to perform a specific function; a "statement" in a computer program.

INTERACTIVE MODE. Direct communication between a person and a computer in "real time."

INTERFACE. A device, usually "firmware", that allows two-way communication between a computer and a peripheral such as a keyboard, a CRT, or a printer.

I/O. Input/Output; data flowing into or out of a computer.

JOYSTICKS. Input units, similar to "game paddles", that permit one to control a computer program by moving a lever in various directions.

K. Kilobyte; a measure of the storage capacity of a computer; one K of memory will store 1024 characters; 2 raised to the power of 10 = 1024.

KEYBOARD. An input unit with keys similar to those on a typewriter.

LESSONWARE. Courseware designed for brief, but complete, instructional sequences.

LIGHT PEN. An input unit that enters data into the memory of a computer in relation to coordinates on the CRT screen.

LINE PRINTER. A high-speed output unit that prints a line at a time, and as many as 2,000 or more lines per minute.

LISTING. A printout of a computer program, either on a CRT or as hardcopy.

LOGO. A programming language specially designed to permit very young children to program computers.

MEMORY UNITS. Computer components that can store programs and data. (See also, RAM and ROM)

MENU. A feature of a computer program that permits the user to select from a list of options.

MICROCOMPUTER. A small, low-cost computer.

MICROPROCESSOR. The generic term for an arithmetic/logic unit on a "chip"; the CPU of a microcomputer.

MONITOR. Another name for a CRT or TV screen output unit.

MUSIC SYNTHESIZER. An input/output unit that permits digital music to be created and "played" on a computer.

NATAL. National Authoring Language; a computer language, designed by the National Research Council of Canada, to facilitate high-level "computer assisted instruction."

OUTPUT. Data leaving a computer to any of several devices.

OUTPUT UNITS. Hardware components that accept data from the memory of a computer; a peripheral device such as a CRT, or a printer.

PASCAL. One of several computer programming languages; a French mathematician of the 17th Century.

PERIPHERALS. Input and output units.

PILOT. Programmed Inquiry, Learning Or Teaching; one of several "authoring languages."

PLOTTER. An output unit that "draws" graphical output from a computer.

PRINTER. An output unit that "prints" numbers, letters, and characters that are output from a computer.

PROGRAM. A set of detailed instructions that control the operations of a computer in performing its task.

PROGRAMMER. A person who "writes" computer programs.

RAM. Random Access Memory; computer memory in which programs and data are stored, the contents of which can be modified by the program currently operating; memory which usually is destroyed when the power to the computer is switched off.

ROM. Read Only Memory; computer memory which can be accessed, but cannot be modified; memory which is not destroyed when the power to the computer is switched off.

SIMULATION. A computer program that is a model of a "real" or "imagined" situation.

SOFTCOPY. Computer output onto a CRT; temporary output.

SOFTWARE. The general term for computer programs.

STORAGE. Devices that hold data until required by a computer; RAM, ROM, diskettes, cassettes.

TELIDON. Canada's "videotex" system by which computer graphics can be sent quickly to computer terminals via telephone circuits.

TERMINAL. An input/output unit that communicates with a computer via telephone circuits or coaxial cables.

VIDEODISC. A storage medium, similar in appearance to a stereophonic recording, upon which color photographs are stored.

VIDEO DISPLAY TERMINAL. VDT; a computer terminal containing a keyboard and a cathode ray tube, or CRT.

WORD-PROCESSOR. A computer program that provides for the entry, editing, and output of textual data such as correspondence and reports; a computerized typewriter.