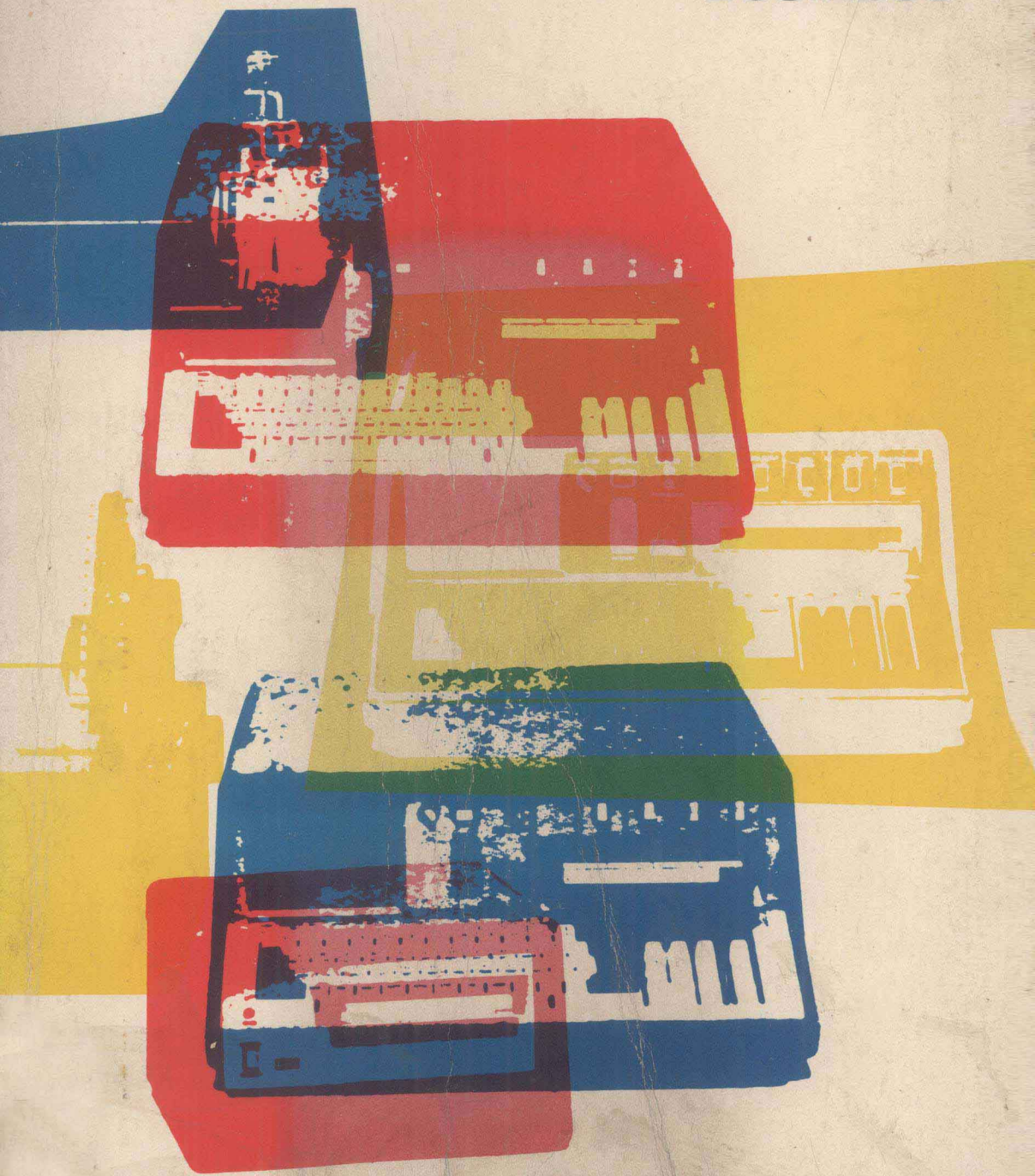
Gerald A. Silver

SMALL COMPUTER SYSTEMS FOR BUSINESS



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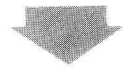

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PREFACE

The minicomputer and microcomputer, small in size but great in power, are being woven closely into the fabric of modern society. They are leaving their mark on thousands of business firms, institutions, schools, universities, and government. They are running our machines and controlling our water supply, communications, and natural resources. Before long, they may even be driving our automobiles and cooking our breakfasts!

In 1973, more than 40,000 small computers were sold, and this total is increasing each year. By 1978, over 700,000 units were in use. Small computers are manufactured in the United States by more than 73 companies, and by dozens more around the globe. They represent worldwide sales of over $1.5 billion. By 1983 they will account for over $3.7 billion.

The cost of minicomputers has dropped sharply from $25,000 to under $5,000, in the last few years—in fact, some even sell for less than $1,000. Microcomputer systems sell for only a few hundred dollars. Few invented tools can claim to cost less each year, weigh less, occupy less space and yet offer increasingly greater power and capacity. The small computer can.

Unquestionably its size is responsible for a large part of the impact of the small computer. Since a small computer weighs only a few pounds, it can be carried, placed in motor vehicles or airplanes, incorporated into machines, or sent deep below the earth in mines or factories. Yet its speed and power rival those of computers, which only a few years ago weighed many tons and cost millions of dollars.

The real success story of the small computer is yet to be written. Science fiction writers of only a few decades ago would be amazed at the prospect of an entire computer built on a chip only a fraction of an inch in size. Yet, today, microcomputers even smaller than minicomputers are realities.

Historians may one day note that no device ever invented has had such an impact on civilization as the computer. It may well rank with the invention of the wheel, fire, or interplanetary spaceships. Indeed, without the computer there would be little or no space travel.

This text presents an easy-to-read and interesting introduction to the world of small computers. It offers a balanced and comprehensive coverage of the subject area which is applicable to large computers as well. It explains the central processing unit, its peripheral devices, and its languages and applications.

Software and hardware are thoroughly discussed in sufficient detail to teach basic theory. Assembler, BASIC, and FORTRAN language principles are presented to enable the student to learn how people communicate with and direct the machine.

Chapters on operating systems and data storage devices introduce the student to core, disk, and tape storage principles. A group of application studies draws upon all the areas covered and integrates them into an organized whole.

The text should be useful to anyone coming in contact with small computers at any of several levels—operators, programmers, users, teachers, students, etc. It provides a clear and balanced introduction to the major elements of the subject—while avoiding excessive details or treatment of one particular brand of machine. The data is presented generically to enable the student to apply this knowledge to many different types of small computers.

The author wishes to thank the various vendors mentioned in this book for their help in providing artwork. It is hoped that with this book, the study of small computers will be an enjoyable and rewarding task.

Gerald A. Silver

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CONTENTS

1

INTRODUCTION TO SMALL COMPUTERS

In the year 1948 two products—both described with lavish adjectives—made their appearance in the marketplace. The major automobile manufacturers heralded their new models as the most stylish, economical, and dependable cars ever offered for the money. And a new line of computers was introduced by several manufacturers as the most reliable, efficient means of processing data ever devised.

Let's see what happened to both these mechanisms during the next 30-year period:

The average 1948 automobile cost about $2,500, had a gross weight of approximately 3,000 pounds, and was capable of highway speeds in excess of 60 miles per hour. Thirty years later, a 1978 automobile cost about $5,000, still weighed around 3,000 pounds, and was capable of approximately the same speed range.

The average 1948 computer cost about $3 million and occupied several large rooms full of complex electronic and air-conditioning equipment. It averaged about 30,000 pounds in weight, and its internal operational speed was measured in thousandths of a second.

Thirty years later, we have the minicomputer—an offspring of these early machines. It costs about $3,000, weighs about 30 pounds, occupies about 2 cubic feet of space, and has an internal processing speed measured in billionths of a second. Microcomputers, even smaller versions, weigh even less, possess similar characteristics, and cost only a few hundred dollars.

What I'd like to know is why McAllister's minicomputer does more words per minute than mine.

Source: From *Computerworld*, June 25, 1975, p. S/13. Reprinted by permission of Gordon Watt.

To equal the same technological development, the automobile of 1978 would possess the following characteristics: it would cost $2.50 (one-thousandth of its 1948 cost), weigh about 3 pounds, and be capable of speeds in excess of 60,000 miles per hour! Obviously, an automobile with these characteristics would no longer be capable of doing its basic task, but the analogy does help to place the development and technology of modern minicomputers and microcomputers in perspective.

WHAT ARE MINICOMPUTERS AND MICROCOMPUTERS?

Just what is this remarkable machine that packs so much power into a minimum of space and dollar cost? A minicomputer is a small, desk-top digital device with a central processing unit (CPU), at least one input/output device, and primary storage capacity of at least 4,000 bytes (characters).

A microcomputer is a complete computer processor manufactured on a single integrated-circuit chip. This small computer processor is about the size of a dime and possesses the same characteristics as larger machines. It is equally fast, and substantially lower in cost (Figure 1-1). The fundamental difference between minicomputers and microcom-

puters is their physical size and construction. Both devices are capable of processing data at high speed, and both cost substantially less than larger computer systems. Both possess high accuracy, and can accept data as input, process it, output the results of processing, or store data for further use.

Computers, both large and small, have made significant changes in the way our society operates. They have removed the drudgery and improved the accuracy and speed of many of the routine tasks and clerical duties found in business, education, science, communication, and industry. Their influence affects us all, regardless of whether we are consumers, business people, teachers, scientists, engineers, or students.

The chances are that in the next few years, in one way or another, each of us will have some contact with computers, especially with minicomputers or microcomputers. If we don't own one in our car or home, or enjoy it as a new national leisure-time activity, we are bound to find one in our place of work.

This text explores the world of small computers—what they are, how they are used, their internal structure, and our means of communicating with them. The fundamentals of data processing and computer systems, presented here, are not only true of minicomputers and microcomputers, they are basically applicable to medium- and large-sized machines as well, regardless of manufacturer, function, or size.

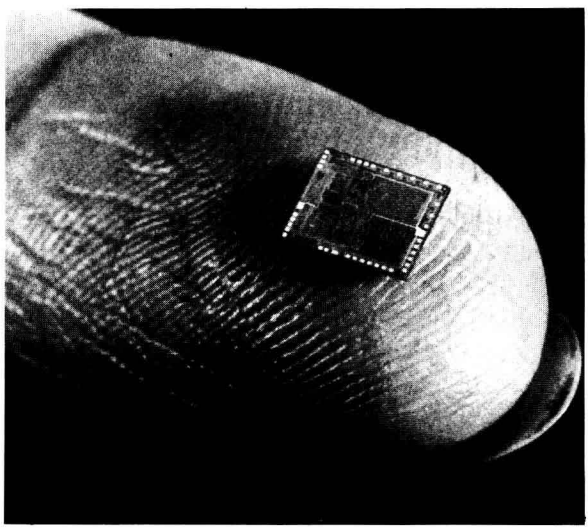

Figure 1-1 Microcomputer.

Source: Intel Corporation.

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ADVANTAGES OF COMPUTERS

Before the computer age, all data processing was done either manually (by hand and eye) or by unit record machines (punched-card processing). These methods were slow, relatively expensive, and prone to errors. The following points are the most significant benefits we have realized from modern computers:

1. Increased Speed

Modern computers perform computations faster than any other computing device yet developed. A computer can perform thousands of calculations in 1 minute. It can manipulate bits of data in billionths of a second. It can sort a million records in a few moments, search a file of a hundred thousand names in a fraction of a minute, or print out processing results at more than 2,000 lines per minute.

2. Increased Accuracy

The electronic computer has attained a level of accuracy unequaled by any other computing device. It can execute millions of computations without making a single error. Modern computers have sophisticated error-detection and checking systems which are designed to alert the operator to potential or existing error conditions. In the few instances where errors occur because of failures in equipment, the computer will often have been programmed to detect the error condition and retry the operation with different circuitry. In this situation, the computer is, in effect, detecting and correcting its own errors.

3. Cost Reduction

Computers have enabled businesses to reduce considerably the cost for processing large quantities of data. The costs involved in computer preparation of monthly bills, inventory maintenance, file searching, manufacturing goods, etc., are much lower than those of such preparation when performed by people.

But, in some instances, the cost reductions have been offset by increased demands on the system. It is not uncommon for a business to install a computer to save money, only to find that its costs actually rise because of greater reliance and dependence upon data processing, and an increased level of precision, detail, and accuracy.

MINICOMPUTERS LIKELY ON ALL NEW MODELS IN 1980

Harry Anderson

Barring some unexpected breakthrough in technology, minicomputers are likely to be part of all new cars by 1980–81 to help meet stricter pollution limits and demands for better fuel economy, according to a top executive of American Motors Corp.

George E. Brown, AM's executive director of vehicle emissions and safety, said that, in order to meet the double goals of economy and pollution control, cars of the 1980s will have to make progress in three areas: (1) more control of exhaust gas as it leaves the engine, (2) more precise ignition control, and (3) better control of the fuel and air mixture being burned.

"I'd think microprocessors (miniature digital computers) are probably in the cards in order to help us maintain the pinpoint control in all three areas which will be needed," Brown said in an interview.

Federal laws require stricter pollution control in 1979 and 1980 while also demanding across-the-board improvements in fuel economy.

Brown said minicomputers are one of the few currently known ways to meet both standards—"unless we have some oddball breakthrough."

General Motors Corp. recently announced that it would make the first use of a microprocessor aboard a production automobile on some 1977 Oldsmobile Toronados. The small computer device will be used continuously to adjust the car's timing for better fuel economy and pollution control, GM said.

GM and the other auto makers are also studying ways to use the complicated electronic devices for other purposes on new cars.

From the *Los Angeles Times*, Sept. 13, 1976. Copyright © 1976 by the *Los Angeles Times*. Reprinted by permission.

4. Increased Reliability

Because most computers are of solid-state design (transistors and integrated circuits), they possess extremely high reliability. They can operate year in and year out with few failures. Since the central part of the computer has virtually no moving parts, wear is almost unknown. Technical obsolescence is the biggest problem facing computer systems.

While computers must, of course, be given a certain amount of preventive maintenance to assure their continued performance, they are not subject to vacation schedules, sick leaves, labor unrest, or a myriad of other difficulties encountered with employees.

5. Size Reduction

The minicomputer and microcomputer are the result of packaging a large amount of sophisticated electronic equipment into a small space.

This has created a device with more processing power, per cubic foot, than can be found in any other machine yet developed.

A smaller device requires less space for storage and operation, which greatly increases the number and kinds of places where they can be located. Whereas large computers often need whole rooms to themselves, small computers fit nicely on desk or table tops, in small cupboards, or in unused corners in a room.

This makes it feasible to locate minicomputers and microcomputers right in the offices where computing power is needed, in classrooms, or adjacent to other machines or devices.

6. Self-guiding

A key element of the modern computer is its ability to remember and carry out a set of instructions, called a program. Once the operator instructs the machine to begin processing, the computer will follow the set of instructions in the program with no further intervention. This enables the machine to perform countless complicated and repetitive processes on data without any further directions. Many other business machines require that an operator monitor or direct each step of the process it is carrying out.

KEY TERMS

As in any discipline, there are certain important terms that the student will need to know to understand the material presented. Below is a short explanation of some of the terms found in a study of data processing and computers. Many of them will be explained in greater detail later in the text.

1. Computer System

An electronic computer is defined by the American National Standards Institute (ANSI) as a device capable of performing systematic sequences of operation upon data, including numerous arithmetic and logic procedures, without intervention by a human operator during the run.

A computer system refers to all the elements that are necessary for performing these activities. Four major components are involved: input, processing, storage, and output (see Figure 1-2). The input system is concerned with entering data recorded in a form suitable for processing by machines. This involves media such as punched cards,

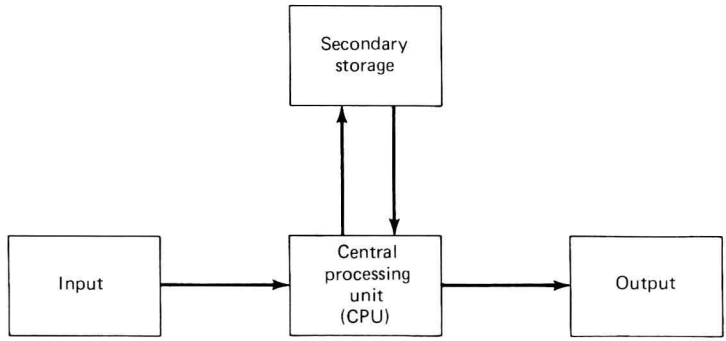

Figure 1-2 Components of a computer system.

paper tape, or magnetic tape. Appropriate devices read the data encoded by this media and transform it into electrical pulses which can be manipulated by the computer.

The processing system manipulates the electrical pulses representing data within a portion of the computer called the *central processing unit* (CPU). This data may be manipulated arithmetically, restructured in various ways (that is, alphabetized, selected, merged), or stored.

The computer has two kinds of facilities for storing or saving data. The first involves saving data in the CPU itself using ferrite cores or semiconductor devices—called primary storage. The second form is called secondary storage. It involves devices located outside the CPU, such as magnetic disk, tape, and drum.

The output system converts the processing results into a form usable by people, or suitable for further processing. In this system, devices connected to the computer, such as line printers, cathode-ray tubes, card punches, or magnetic tape units, are utilized to produce the output.

Electronic computer systems vary in their physical size, their primary storage capacity, and the number and kinds of output and input devices they have. Figure 1-3 illustrates a rather large computer system. It has a primary storage capacity of many millions of characters (bytes) and is equipped with many input and output devices. Systems such as these can cost several millions of dollars.

2. Stored Program

An important feature of the modern electronic computer is its ability to remember instructions. Originally, computers were directed to per-

Figure 1-3 Large computer system—Univac 1110.
Source: Univac Corporation.

form the appropriate set of operations by wiring their circuits in the proper arrangement. When a new set of operations was necessary, the physical wiring layout was changed, or a new wiring board was inserted. This was time-consuming and subject to error and greatly limited the facilities of the computer.

The development of a computer which could receive its instructions through its input system and store this information for future use was a major step forward. This allows the operator to direct the computer conveniently to perform a variety of operations by merely changing the input data. The data used to direct a computer through a series of actions is a set of instructions called a *program*. The computer is designed to input these instructions, save them in its primary storage unit, and execute each statement in turn.

The instructions in a program are written by programmers in a specially designed language which serves as an interface between computers and people. Figure 1-4 illustrates a program written in a language called BASIC. Other common languages are FORTRAN, COBOL, and APL. The most common means of inputting a program into the computer is to punch each instruction into a card and enter

```
10 REM SEWING SUPPLY INVENTORY (SEWINV)
20 PRINT "                              SEWING SUPPLY INVENTORY"
30 PRINT
40 PRINT "..................................................";
50 PRINT "................."
60 PRINT
70 PRINT
80 PRINT " ITEM        SALES PRICE       NET COST         PROFIT";
90 PRINT "           PERCENT"
100 PRINT
110 READ A$,B,C
120 IF A$ = "ZZZZ" THEN 250
130 LET D = B-C
140 LET E = D/B
150 LET F = E * 100
160 PRINT A$,B,C,D,F
170 GO TO 100
180 DATA "PINS",0.49,0.31
190 DATA "NEEDLES",0.69,0.47
200 DATA "THREAD",0.45,0.21
210 DATA "SNAPS",0.59,0.36
220 DATA "BUTTONS",0.63,0.48
230 DATA "BOBBINS",0.79,0.51
240 DATA "ZZZZ",99,99
250 END
```

Figure 1-4 FORTRAN program.

Source: Silver and Silver, *Simplified BASIC Programming*, p. 241, McGraw-Hill, New York.

this data via a card reader. The computer will carry out each instruction in turn, read in data to be processed, add values, alphabetize names, etc., and finally output the results as directed by the program.

3. Central Processing Unit (CPU)

The CPU in the computer consists of three parts: a primary storage section, an arithmetic/logic section, and a control section. These are shown in Figure 1-5.

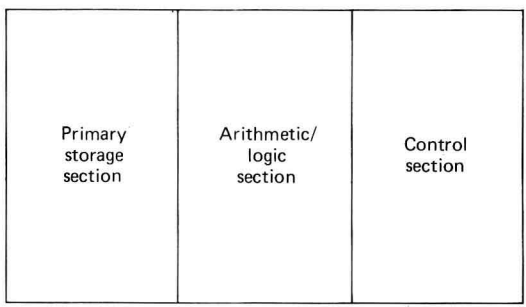

Figure 1-5 Central processing unit.

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