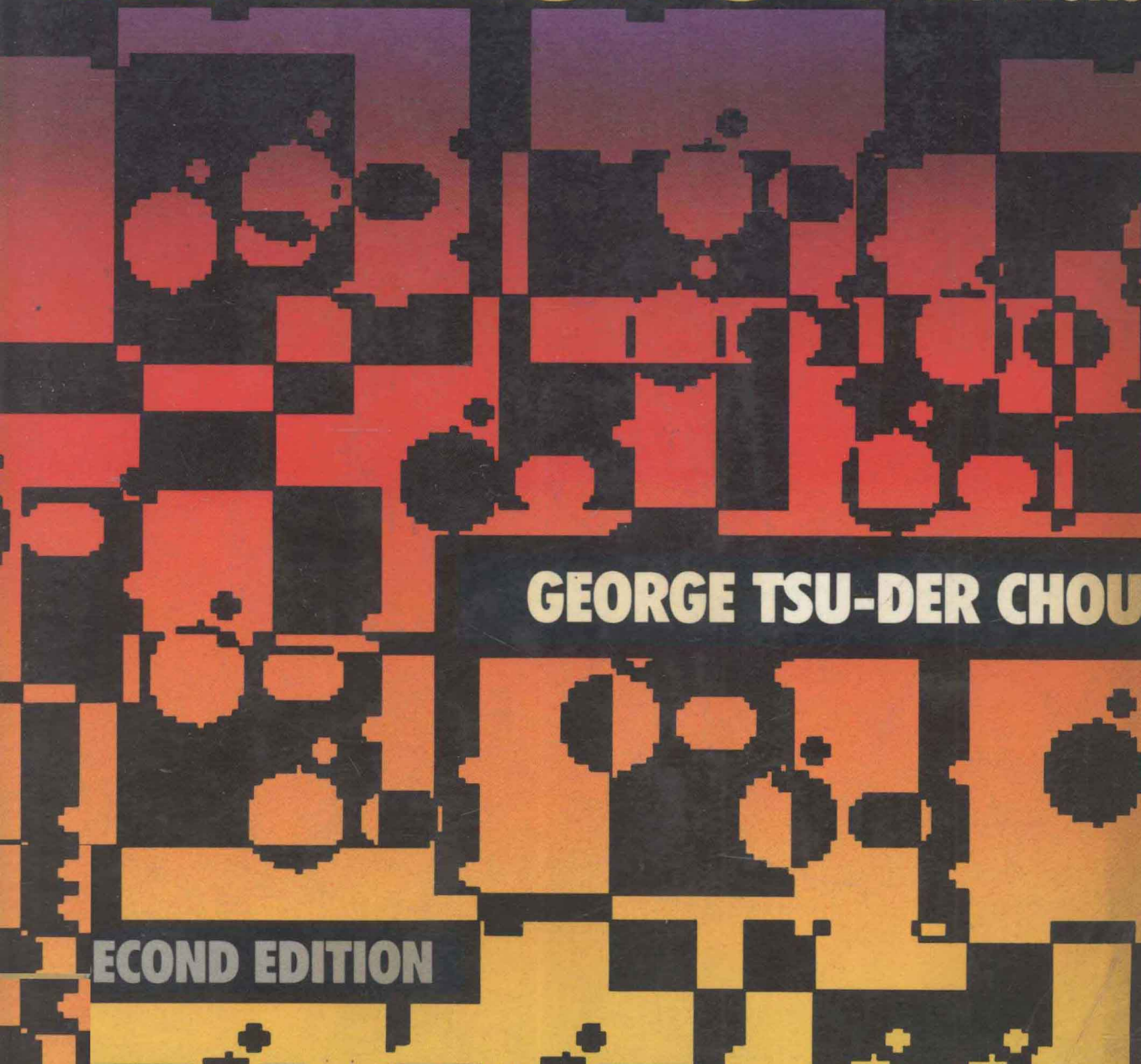
MICROCOMPUTER PROGRAMMING IN BASIC

with BUSINESS APPLICATIONS



GEORGE TSU-DER CHOU

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with Business Applications
2nd edition

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University of Portland

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To my wife,
Jane-Wen,
and our children,
Doris, Tina, and Thomas

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Preface

This book is an introduction to computer programming using BASIC, with an emphasis on understanding and correctly using this programming language. Although there are many different versions of BASIC on different computer systems now being used, this book tries to discuss the principle of computer programming independent of any specific computer system. This book may be used for learning computer programming in BASIC on a time-sharing computer system such as DEC's VAX 11 as well as for microcomputers such as the APPLE II, APPLE III, TRS-80, the IBM PC, and the Osborne under the CP/M's CBASIC and MBASIC systems. Designed for use as a college text in a one-semester or one-quarter computer programming course, this book may also be used as a self-learning guide. It is not, however, a reference manual for any specific BASIC computer system.

BASIC was originally developed at Dartmouth College as an easy-to-learn, simple-to-use programming language. Since then, many different versions of the language have been implemented in various computer systems that include mainframes, minicomputers as well as microcomputers. Because there are significant differences in programming features among these versions of the language, any attempt to cover all of these in one book would be an impossible task. Thus, this book attempts to concentrate on those programming features that are more or less universal among different versions of BASIC now being used. Readers are advised to consult the system manual for any special programming commands that may be unique to a specific computer system.

From 14 years of teaching experience, this author has found that a major concern of students in a programming course is the relevance of examples in the text, particularly when the programming language itself can be mastered in a short time such as the BASIC language. In order to provide relevant applications and convey an appreciation of the language's usefulness, this text uses three categories of examples. They are:

1. *General* applications, which do not require a special knowledge of any specific subject

2. Applications to *business and economics* (or finance)
3. Applications related to *mathematics and statistics*

requiring only a knowledge of elementary algebra (calculus or matrix algebra is not required).

The headings of these examples indicate which application, and readers may disregard any examples in subject areas not familiar to them.

This text is divided into 12 chapters. Chapter 1 presents an introduction to basic computer systems and the concept of computer programming. It also illustrates how to program a time-sharing computer and a microcomputer by using the language BASIC. Chapter 2 provides an overview of the programming language and introduces essential programming features, enabling the reader to write his or her own program at an early stage.

Once oriented with these basic programming features, the reader may proceed to Chapter 3 for proper understanding of programming logic. Training in programming logic can be achieved most effectively through the use of flowcharts. Thus, the principle of flowcharting is the main subject of Chapter 3.

Chapters 4 and 5 present a detailed discussion of programming instructions related to input and output operations. Chapter 6 discusses various forms of arithmetic expressions, the crux of most computations. Chapter 7 deals with the use of transfer statements in a program, while Chapter 8 presents the important concept of program loops. Chapters 9 and 10 present the use of arrays—single-dimensioned lists and double-dimensioned tables—in data processing from a nonmathematical approach. Lists and tables are illustrated as effective methods of handling a large quantity of data.

Chapter 11 discusses the concept of functions and subroutines. These are the very powerful tools in writing a large and complex program. In this chapter both built-in library functions and user-defined functions are discussed. Chapter 12 deals with an increasingly demanding programming feature—the use of data files. Both random files and sequential files are covered. Since there exist significant differences among different BASIC under various disk operating systems, the two most popular versions—the Applesoft BASIC under the Apple DOS, and the IBM PC's Advanced BASIC under its MSDOS—are used for illustration.

The procedure that is required to get on (log on) and get off (log off) a time-sharing computer, such as the PDP-11 and BASIC-Plus systems, is illustrated in Appendix A. Appendix B discusses some of the useful commands that can be used to manipulate a BASIC program in a typical computer system.

Each chapter ends with a large number of exercises. Selected exercises, indicated by an asterisk, are solved in part or completely and explained immediately following the exercises themselves. Besides giving readers instant feedback, these solutions will help in a review of the materials introduced in the preceding chapter.

In order to provide as many examples of different computers' outputs as possible, programs shown in this book are executed on a number of computers,

including the DEC's VAX11/780 time-sharing computer, the Apple II, and the IBM PC, as well as others. In most cases the same program should be able to run on most BASIC systems, except in the cases so noted in the text that require modifications.

The author would like to express his sincere appreciation to Professors Robert Fritz, William Shrode, G. Kent Steams, George Miller, William Bocchino, William Ledbetter, John Westley, Sultan Bhimjee, Donald Ketchum, Larry Weiner, E. C. Hoffman, Robert Gunston, and Steven Deam for their valuable comments and encouragement during the review of the first edition of this book. The author is also grateful to editor John Willig and Harper & Row, Publishers, for their cooperation.

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1
Introduction to Computers and Programming

Electronic computers, originally developed to provide a computational tool to help perform time-consuming, tedious calculations, now are important tools for helping in problem solving and decision making. As they become increasingly abundant and readily available, the ability to use a computer properly also becomes a vital skill in our society. This in turn requires familiarization with the computer system and a knowledge of programming.

BASIC COMPONENTS OF A COMPUTER SYSTEM

Computing usually involves three basic operations:

1. Input
2. Processing or computing
3. Output

Input
Processing

In the input operation the computer is supplied with necessary data and processing instructions. In the processing operation the input data is processed and the answers computed according to the instructions. In the output operation the answers or results are reported back to the computer user.

Output

Although the configurations of computer systems differ according to their different computing needs, a typical system usually consists of three main components:

1. An input unit
2. A central processor
3. An output unit

Each performs one of the three basic operations described above—input, processing, and output.

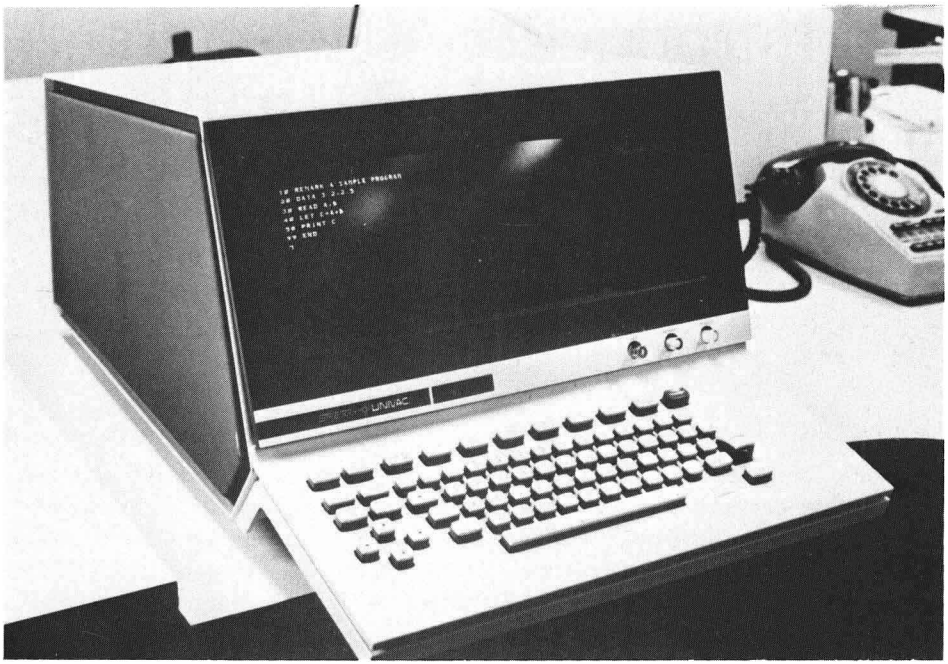

Figure 1.1 CRT terminal

The Input Unit

Input Unit

The input unit includes all the devices for transmitting the information from the input medium to the central processor. The choice of input devices for a computer system depends on the type of input medium used, but two of the most commonly used devices are the card reader and the remote terminal.

Remote Terminal

A remote terminal transmits to the central processor the information entered by a computer user on a terminal keyboard. The terminal itself may be physically located far away from the central processor and linked with cables or wires or telephone lines. Remote terminals vary according to how the information is

CRT Terminals

displayed on the terminal. CRT terminals (see Figure 1.1) display the data on a

Teletype

television screen or cathode-ray tube (CRT). Teletype or other print terminals (see Figure 1.2) are like a regular typewriter, printing the information on paper as it is

Print Terminals

keyed in.

The Central Processor

Central Processor

The central processor represents the "brain" of a computer system; it carries out all the processing and computational tasks. A central processor, also called a central

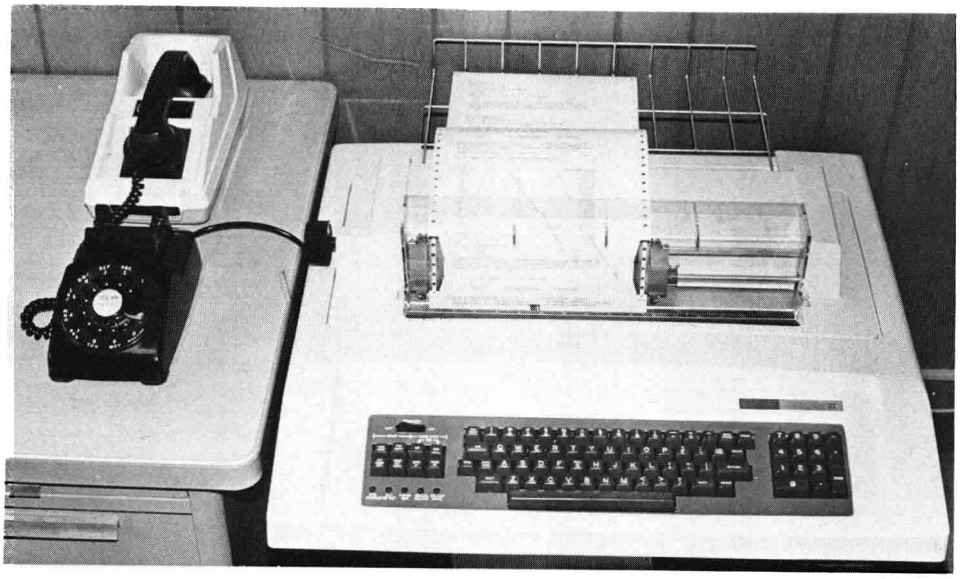

Figure 1.2 A print terminal

processing unit (CPU), usually consists of three main components:

CPU

1. The primary storage (or memory)
2. The arithmetic/logic unit
3. The control unit

The primary storage represents the main memory of a computer system; it stores the data and instructions supplied by the computer user and the instructions for operating the system. Processed answers and results may also be stored here.

Primary Storage

The primary storage device used in most main-frame computers is the magnetic core. For most microcomputers the primary memory is the RAM (the Random-Access Memory), which is a form of semiconductor memory device. Although they represent different memory technologies, both perform virtually the same function of program and data storage.

RAM
Random Access Memory

The arithmetic/logic unit contains all the electronic circuits, which are similar to those found in a hand-held calculator, for performing the arithmetic calculations and logical comparisons.

Arithmetic/Logic Unit

The control unit acts like a traffic director; it controls and directs the flow of information between the input/output units and the central processor. An important function of the control unit is to ensure a smooth processing sequence and a proper use of the limited memory spaces available.

Control Unit

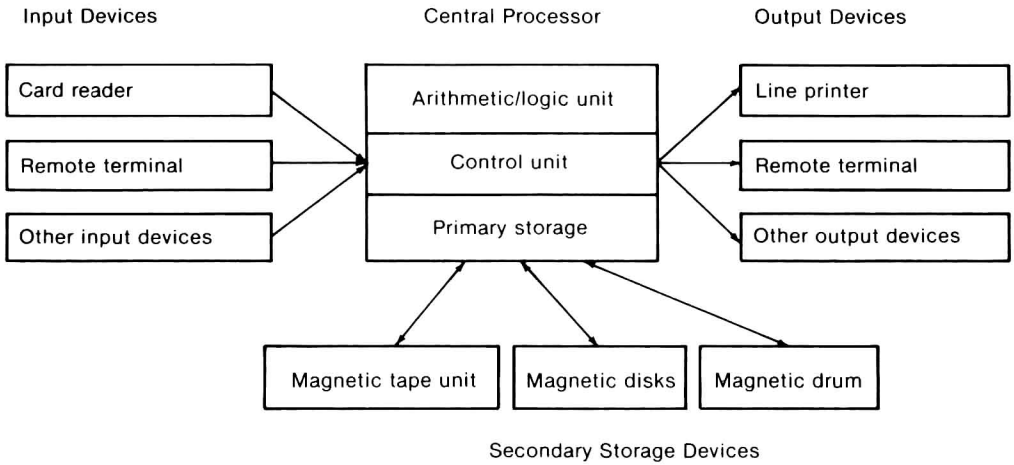

Figure 1.3 A typical computer system

The Output Unit

Output Unit

Line Printer

The output unit consists of devices that report the processed results back to the computer user. Two of the most common output devices are the line printer and the remote terminal. The line printer prints the results on a sheet of computer output paper. Computed results and information can also be displayed on a CRT terminal or printed on a teletype or print terminal.

A Typical Computer System

Secondary Storage

Although computer systems differ in configurations of devices and equipment, a typical system consisting of three main components just described (input, central processor, output) is shown in Figure 1.3. In addition, this illustration shows a secondary storage (or memory), which is often added to a computer system to supplement the primary storage in the central processor. Secondary memory devices used in most main-frame and minicomputers include magnetic drums, magnetic tape units, magnetic disk units, and others. In a microcomputer the most commonly used secondary memory is the floppy disk drive (see Figure 1.4). The storage medium used in a floppy disk drive are floppy disks, which come in one of the two popular sizes—a five-and-quarter-inch and an eight-inch (diameter) disk.

PROGRAMMING A COMPUTER

Programming a computer is similar to devising a set of instructions for using a hand-held calculator to perform a computation. The set of instructions specifies the

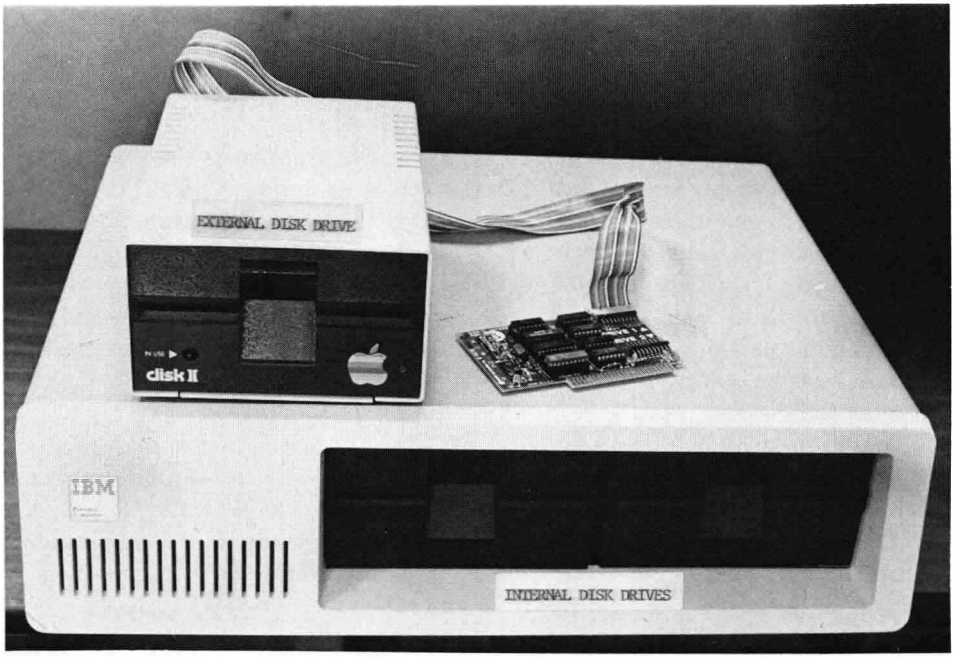

Figure 1.4 Disk drives

data needed in the computation, the arithmetic operations to be made on the data, and the desired answer to be reported. For instance, a set of instructions for computing the sum of two values, 2.5 and 3.2, with a hand-held calculator may be specified as follows:

Step 1: Enter (key in) the first value or the addend, 2.5.
Step 2: Press the + key for the arithmetic operation.
Step 3: Enter (key in) the second value or the adder, 3.2.
Step 4: Press the = key.
Step 5: Read the sum from the display.

In principle, the set of instructions shown above represents a form of a computer program. It specifies all the necessary data (2.5, 3.2) and the arithmetic operation (addition, +) and the answer (sum of the two values) for the computation. However, there is a significant difference between performing calculations on a hand-held, nonprogrammable calculator and programming an electronic computer. The former performs the calculation manually step by step *while* data is being entered in the