INTRODUCTION TO COMPUTERS

Alton R. Kindred

ALTON R. KINDRED

Manatee Junior College, Bradenton, Florida

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Preface

In a short quarter-century, the electronic computer has made an enormous impact upon business, industry, science, education, and our society in general. Scarcely an occupation or an academic discipline has not been profoundly affected by the speed and tireless capacity for work that the computer affords.

We have reached the point where every literate person needs to understand something about the way in which a computer works, its power and limitations, its uses and abuses, its capacity for service and for mischief. Nearly every college now offers a course introducing students to the concepts of the computer, and usually providing in addition some elementary programming language and some fundamentals of data processing techniques and practices. Although this course is generally offered as an elective, the time may be nearer than we realize when it will become a required part of each student's general education.

Some colleges offer several introductory computer courses, designed for differing publics. One is intended for the mathematically oriented computer science major, another for the business data processing student, and a third for the student who wants only a general idea of what a computer can do. I believe that there are more common needs than differences in these three groups. This book is designed to serve both the computer major and the non-major, both the science-oriented and the business-oriented student, both the serious student and the casual reader. Every attempt is made to keep the language simple and straightforward. There are no specific prerequisites in mathematics or any other area.

The book has three principal objectives:

1. To make the reader literate with regard to the parts and functions of the computer and the applications in which it is employed
2. To serve as a foundation for further study by the person aiming at a career as a computer programmer, operator, analyst, or manager
3. To combat and eliminate the misinformation, fear, and mystery that have grown up around the computer.

To meet these objectives, I have followed certain convictions based on more than twenty years of experience as a data processing user, teacher, programmer, and analyst:

1. A properly written text can adequately serve both computer majors and non-majors and both business and scientific users.
2. The text should always move from what the student already knows to what he has yet to learn. In this respect, it may appear to be written almost backward from the sequence followed in many other books.
3. An introductory text should be broad rather than deep. The vocabulary of the computer should be introduced and general principles and practices explained. But to try to treat each topic in detail can drown, rather than quench, the thirst for knowledge.
4. This book contains all the material in course B1 of the Association for Computing Machinery's *Curriculum 68*, yet it is presented in nontechnical language, suitable to the community college or technical institute as well as to the university.
5. Some programming, as early in the course as possible, is essential for an adequate understanding and appreciation of the computer. A choice of languages is presented so that one may be selected for concentration if desired throughout the course.
6. There is an abundance of exercises and problems contained within the text itself. No additional workbooks or study guides need be purchased. The material increases in difficulty as mastery of the subject develops.
7. Although it is strongly recommended that the text be followed as written, any chapters or sections may be omitted without seriously affecting the following material.
8. It is important to know what a book is about and what it does not cover. This one is about computers. It is not about mathematics, engineering, business administration, or management, although it shows many applications of computers to those areas. It is not filled with cartoons, crossword puzzles, gimmicks, and quotations from Shakespeare.

The material in this text has been used in manuscript form in classes at Manatee Junior College and has been revised and modified on the basis of that experience. My thanks are extended to my colleagues Robert D. Onley, F. Ronald McCord, and Dianne C. Saunders for their valuable suggestions from the point of view of teacher and student both before and during the preparation of the manuscript.

I also am indebted to Professor Thomas G. DeLutis and Professor E. C. Laedtke, who reviewed the manuscript and made many suggestions for its improvement. Garret White, Judy Rothman and Cheryl Smith of Prentice-Hall, Inc., gave their usual splendid guidance and support. Nancy Bartels and Diane Beck spent many overtime hours in typing the manuscript.

As always, my wife Lucia was an incomparable help in bringing the project to a conclusion. She typed many drafts, photocopied and collated the student copies, gave constructive criticism, and endured many inconveniences as the book was being prepared.

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As we begin our study of the computer, it must be acknowledged that each of us may have a different motive for reading this book. Some of us expect to become professional computer programmers or operators. Others realize that we are likely to encounter the computer in almost any occupation we choose to follow. Still others, possibly the majority, finding our private lives more and more affected by the computer, simply wish to understand enough to separate the facts from the myths and misinformation about it.

Many of us are already somewhat acquainted with the computer and some of its uses. We receive our paychecks and our annual statement of earnings from our employer as prepared by a computer. We know that many of the bills and statements we receive each month have been calculated and printed by a computer. On television or in the movies, we may have seen plots, some realistic and some fantastic, dealing with the computer. But few of us are fully aware of the extent to which computers have reached into almost every area of modern life. It is the main purpose of this chapter to give a few basic definitions and concepts and then to explain in somewhat general terms some of the manifold ways in which computers are applied to solving the problems of a complex modern society.

We will look at some of the more common—and a few of the more exotic—ways computers are used. We intend to strip away much of the mystery and misinformation surrounding them and try to gain a balanced perspective of their strong and weak points, their successes and failures, their costs and economies, and other necessary facts to help us know how best to employ them.

First, just what is a computer? The term *computer* literally means

any automatic device for performing calculations; however, it most commonly refers specifically to electronic computers. Operations performed by a computer are called *data processing, electronic data processing* (EDP), or *automatic data processing* (ADP). Finding out specifically what these terms mean is the purpose of this book.

Some of the questions we expect to answer in this chapter are these:

What do we mean by computer applications?
What is *data*, and how is it processed by machines?
What types of processing do the machines perform?
What types of organizations make the most extensive use of computers?
What are some of the advantages and disadvantages of different forms of computer usage?
What can computers do best, and what are they unsuited to do?

We need several basic definitions and concepts to use in our analysis of computer applications. An *application* is basically the job or task to which a computer may be applied.

TYPES OF COMPUTERS

Computers may generally be regarded as being special-purpose or general-purpose. *Special-purpose computers*, as the name suggests, are able to perform only a limited number of functions. They are usually highly efficient and faster than general-purpose computers but more restricted in their application.

The *general-purpose computer* is capable of carrying out a wide variety of instructions. The computer programmer uses his expertise and ingenuity to employ the instructions in any way that he chooses.

A second way of classifying computers is as analog and digital computers. We usually say that an analog computer measures, whereas a digital computer counts.

Analog computers are used primarily in engineering or scientific computing. They are designed to accept physical forces, such as electrical voltage, forces, pressures, speeds of rotation, temperatures, or other phenomena, and record them as readings along a continuing scale. The thermostat and the automobile speedometer are elementary examples of analog computers.

The *digital* computer accepts specific, discrete data. Most digital computers are used in business applications. Since they are the most widely used type of computers, most of our attention will be devoted to them.

DATA AND INFORMATION

The word *data*, as used in this text, is considered a collective noun, like *news*. Data is a set of facts about some person, thing, or event. We speak of a data *element*, such as date of birth or Social Security number, as being a general class or category of data. The specific value the data element has at any given time, such as January 8, 1922, or 263-24-1796, is a data *item*, which relates to a specific person.

Data ordinarily becomes meaningful only when it has been collected, processed in some way, and related to other data to form usable *information*. Collecting, relating, and combining data have been done for years in various manual, mechanical, electrical, and electronic ways. The term *data processing* is normally applied to the use of electronic computers and related machines that can process data automatically at high rates of speed with remarkable accuracy.

Characters, Fields, and Records

Data is made up of numerals, letters, and, to a smaller degree, special character symbols. The characters or letters are put together in strings of different lengths, called *fields*. For example, a typical name field for a student or employee, showing last name first, then first name, then middle name or initial, with spaces between, requires 20 to 24 spaces. A Social Security number field needs 9 spaces, if we omit the hyphens that are usually printed to make the number more readable. In working with computers, we must figure the best field size for each type of data element and then adjust the data items by padding with zeros or blanks to make all data items that occupy that field a uniform size.

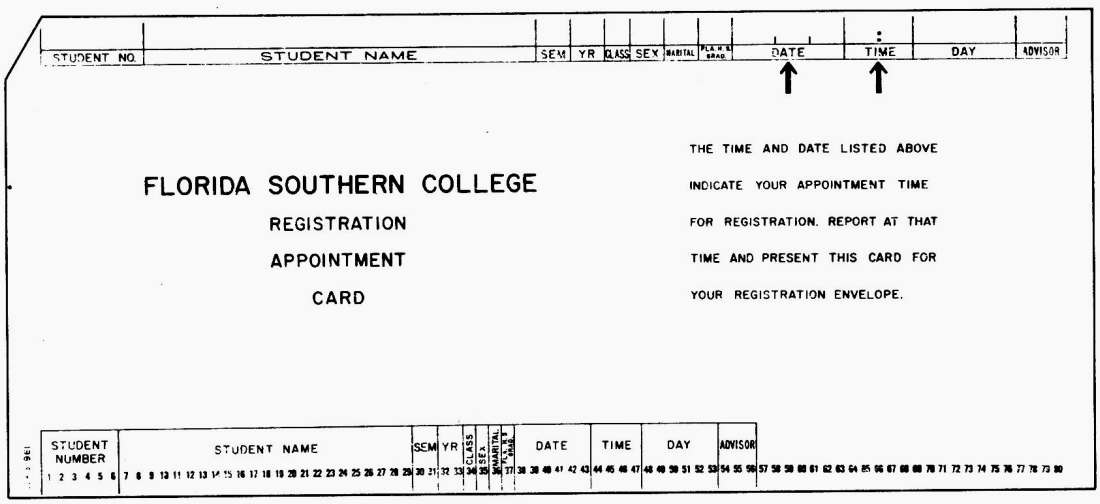
The related fields that concern one person, transaction, or thing are normally grouped together into a *record*. For example, a record about a student might contain such data elements as name, parent's name, address, current grade or class, program or major, credits or hours earned to date, courses taken during the current semester, and many others.

Figure 1-1 shows a punched card record divided into fields.

Files

A *file* is a collection of records organized for some particular purpose. The purpose for which the file is to be used dictates to a large degree the amount of data each record in the file contains. For example, in a college, one file might give the name and a great deal of other information about every student who has ever attended the institution. A second file might contain information on only the students enrolled during the current semester. A third file might give the name and more limited data about each student who lives in a particular dormitory.

FIGURE 1-1. Punched Card Record Divided into Fields



Transaction Files. A *transaction* is some event or happening about which we wish to collect data. For example, a student might file application for admission to a college or university. The receipt of the application is one of a series of transactions about which we wish to make a record. From the student's application form, we can extract many relevant items of data and record them into punched cards or some other medium that machines are able to read and process. Later transactions would include receiving the student's transcript, notifying him of his acceptance into college, receiving his room reservation or tuition deposit, registering him for courses for a specific semester, and recording his grades at the end of a semester.

Most transaction files do not need to repeat data elements that have been already recorded. Normally they include only some specific *identifier*, such as student name or Social Security number, and then record specific data about the transaction itself, such as date, type of transaction, dollar value, grade, room assignment, or other specific item.

A listing of the transactions for any given day, week, or month is frequently called a *register*, *log*, or *journal*. In accounting, we have such transactions as cash receipts, charge sales, cash disbursements, and journal entries.

Master Files. *Master files* normally contain more extensive information than do transaction files. They show the condition or status of a student, employee, or account at any given time. Transaction files are

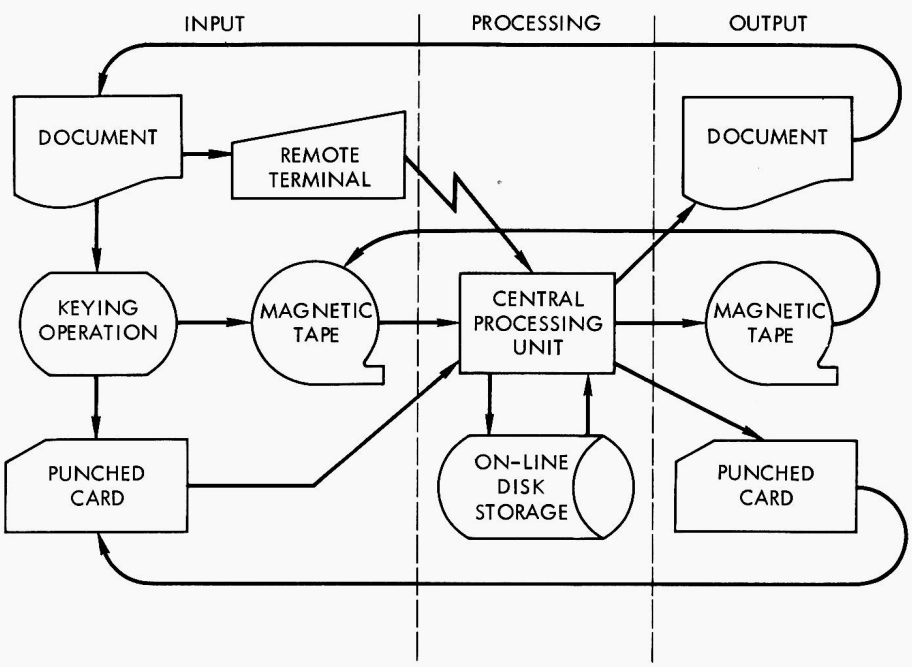
used to make necessary updates or changes in master files. For example, the total semester hours earned to date in a student master file would be updated at the end of each semester as the transactions showing grades and credits for each course are processed.

THE DATA PROCESSING CYCLE

As stated earlier, data processing involves taking certain data elements, organizing or relating them together in some way, and producing usable and meaningful information. Steps by which we do this are usually called *input*, *processing*, and *output*.

We refer to data processing as being a *cycle* because of the fact that the output from one stage of processing is often used as input at a later time. It is therefore important for efficient operations to put some of our output on a type of medium or electronic device that can be read automatically by the computer as input at a later time. (See Figure 1-2.)

FIGURE 1-2. The Data Processing Cycle



Input

Data can be entered into a computer system only when it has been captured and recorded in a form that machines can read. Modern electronic computers are able to sense or *read* data from punched cards, punched

paper tape, magnetic tape, magnetic disks, optical marks, optical characters, typewriter keyboards, embossed plastic cards, and many other forms.

Origination. Input data *originates* when some transaction takes place. It is important to capture all the data you expect to need at the time and place that the transaction occurs. Determining exactly what data to expect is all a part of the design of a computer system, which will be discussed in Chapter 3.

Recording. Ideally, all data about a transaction is *recorded* initially in some form that machines can read. Where this is not possible, the data should be recorded in a form so arranged that it is easy to transcribe at a later time into punched cards, magnetic tape, or some other media that are machine-readable.

Great care and accuracy must be used in recording the data, since any missing detail about the transaction may be difficult, if not impossible, to reconstruct at a later time.

Classifying. Often, in processing data into usable information, we must ensure that similar items are grouped together. The process of determining what group or class something belongs in is called *classifying.*

Usually we assign a *code* to some class of transaction or data item. The code not only requires less space but is more precise than a general narrative description. For example, if we offer 1,000 different majors in our college, we might use numeric codes ranging from 000 through 999 to classify these majors, rather than using names such as aeronautical engineering, biochemistry, or quantitative analysis.

Transcribing. Once the essential facts about a transaction have been recorded and classified, they are ready to be *transcribed* into machine-readable form. The most common transcription process historically has been to *keypunch* data from a handwritten or typed paper document into fields of a punched card. The punched cards are collected into a batch and later read into the computer system. Figure 1-3 shows the relationship between the fields on a document and those on a punched card.

Increasingly, data is being transcribed on magnetic tape, which may be processed faster than punched cards and requires less storage space.

Another form of transcribing that is growing rapidly is the use of a keyboard that is attached by means of telephone or other communication lines directly to a computer system. Transcribing directly into the computer keyboard saves time over keypunching, but does increase the danger of error or of destroying data already in the computer files.

FIGURE 1-3. Relationship Between Fields on a Document and Those on a Punched Card

EMPLOYMENT AUTHORIZATION

SOC. SEC. 543-21-6789

NAME: WAVERLY (LAST) FRANCES (FIRST) B. (INITIAL)

SEX: M (F) DATE OF BIRTH: 08-29-49

DEPT: ACCOUNTING (NAME) 36 (CODE)

JOB TITLE JUNIOR ACCOUNTANT (NAME) 412 (CODE)

RATE 3.75 J.B. Smith (AUTHORIZED BY)

EFFECTIVE DATE: 03-15-XX

543216789	WAVERLY FRANCES B	F	082949	036	412	00375	0315XX
SOC. SEC. NO.	NAME	SEX	DATE OF BIRTH	DEPT.	JOB	RATE	DATE EMPLOYED
1-9	10-29	30	31-36	37-39	40-42	43-47	48-53

Processing

Once the data we wish to use is available in machine-readable form, we are ready to begin *processing*. Some of these steps, such as sorting a group of punched cards using a high-speed sorter, may be done before the data is entered into the computer system, or *off-line*. Other steps are done by means of instructions, or *programs*, carried out within the computer and are called *on-line*. Both data and instructions are placed internally in the main storage of the computer in the form of magnetic codes.

Sorting. The term *sorting* means placing a group of records into the desired sequence. Typically, transaction records are sorted into the