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DATA PROCESSING Made Simple

Susan Wooldridge

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Foreword

Computers have been used for processing data for less than thirty years. In that short time, so rapid has been the growth of the computer industry and so widespread has become the use of computers, that today the term 'data processing' is synonymous with 'computerised data processing'. No one living in a high-technology society can escape their influence. School records, tax records, employment records, census data, bank accounts, telephone, gas and electricity accounts are all processed by computer. Moreover, anyone employed in the Civil Service, local government, a nationalised industry, or any medium-sized or large private business probably has some contact with computer systems in his day-to-day working life. It has been estimated that ten per cent of the working population in this country is *directly* involved with computer systems—if not in the computer department itself, then in preparing input or using the end-product, the output.

It behoves every one of us to have some knowledge of the technology and the business procedures that so profoundly affect our lives today. It is the purpose of this book to provide that background knowledge. The text is comprehensive, and should give the reader who is employed in business or government a thorough understanding of the principles and practice of computerised data processing. It is also intended as a textbook for students at universities and technical colleges who are preparing for recognised examinations. Finally, it is an introductory text for those who are preparing for more detailed study, by taking a degree in computer science, or by working in the field of data processing as an operator, programmer, systems analyst, or manager.

Unlike many earlier texts on this subject, this book concentrates almost entirely on the use of digital (as opposed to analogue) computers. While some analogue computers are in use today, the development of the industry has been such that they are almost always used for specialised applications, and are often purpose-built for a specified job. Users of analogue computers are likely to be engineers or scientists first, and computer people second. Their need for computer education will therefore be much more narrow and specialised than the requirements of readers of this book.

Many digital computers are, of course, used for scientific work in government or industry research centres and at universities. These computer users also have a much more specialised interest, and will talk the language of nuclear physics or molecular biology or socio-psychological dynamics, rather than the language of business. No attempt has been made in this book to cater for the very special interests of such groups.

This book is, therefore, aimed at the business and the computer science student, the manager, and the new entrant into the field of

data processing. It will give a thorough and up-to-date grounding in the realities of commercial data processing. The contents will also be of interest to the concerned general reader who wishes to improve his or her understanding of how computers work and of their probable future impact on the worlds of tomorrow and the day after tomorrow.

S.W.

Foreword to Second Edition

In the years since the first edition of this book was prepared, there have been changes in the computer field. This edition has been completely revised and expanded to take these changes into account.

The growth of computer technology in the last few years has been extremely rapid, and is still accelerating. One American computer expert recently calculated that if a similar level of technological development had been sustained in the automobile industry, a Rolls-Royce would today cost $2·50 and run 2,000,000 miles per (US) gallon. The present text discusses this new level of computer technology, with new illustrations.

This new edition also includes discussions of a number of new trends and developments in the world of commercial data processing. These include the rapid growth of micro- and mini-computers for both home and office use; word processing and the 'automated office'; the advent of distributed data processing; and the continued growth of data-base oriented systems.

A further major change to the book is the addition of sample questions for students preparing for certification examinations in data processing. These will be found at the ends of chapters, as relevant. Finally, numerous minor corrections and additions throughout the text have been made.

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Detroit, August 1980

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DATA PROCESSING Made Simple

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has been created
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but can equally well
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CHAPTER ONE

MODERN DIGITAL COMPUTERS

In this first chapter, we shall discuss the computer as a piece of equipment, and describe the difference between digital and analogue computers. There will also be a brief review of the kinds of things computers can and cannot do. Finally, there will be a survey of the major manufacturers of computers and the types of machines that they make. Later chapters will cover in more detail the mechanics of various parts of a digital computer.

It is first necessary to dispel some myths about computers. Radio, television, and the popular press have done a great deal of damage in spreading misunderstandings and half-truths about computers and how they work.

'The computer sent a letter . . .'
'The computer made a mistake . . .'
'The computer has spelled his name wrong . . .'
'Are computers taking over?'
'The computer brain has calculated that . . .'

All of this is nonsense. It would be as logical to say that the typewriter sent you a letter, telephones are taking over, your watch has made a mistake, the Xerox machine made a spelling error, or that your motorcar calculated it should make a right turn. A computer is a machine like any other machine. It was invented by human beings, built by human beings, and operated by human beings. The technology involved is no more advanced than that of a pocket calculator, an expensive camera, or a transistor radio. In terms of 'mental power', computers are very stupid indeed; your dog or cat is a genius compared to the most powerful computer in use today.

If it is all so simple, then, why are computers so expensive and apparently so complicated? The answer to that lies in the nature of electricity, for computers are essentially electronic rather than mechanical. Counting up to one is no great feat, but being able to count up to one millions of times a second is. Electricity moves at speeds approaching the speed of light, and a computer can count up to one virtually as fast as the electric current in it can be altered. There is another important fact, too; no matter how many times the computer counts up to one, as long as there is no defect in the wiring and no failure of electrical current, it will never make a mistake. These two factors, speed and accuracy, are what make computers such useful machines.

The Basic Units of a Computer

Next time you change the batteries in your transistor radio, look at the insides. It consists of transistors, printed circuits, and bits of wire

connecting the various parts. The insides of a computer are made up of essentially the same things, except that there are more of them and the parts are connected in more complicated ways.

The generations of computers are determined by the technology that built them. First-generation machines used tubes and valves, like old-fashioned radios. Second-generation computers were made possible by the invention of the transistor. The third generation is defined by a combination of advances in solid-state electronics and a marked increase in the complexity of the kinds of tasks computers can undertake. (But all these tasks still depend on counting up to one.) The fourth generation has taken the form more of an evolution than of a revolution. It is marked by rapid advances in solid-state electronics, microminiaturisation, and the development of radically new memory systems, such as 'bubble' memories.

To return to our analogy between a transistor radio and a computer, a radio has various parts for performing different functions; reception, tuning, boosting the signal received to make it audible, and so on.

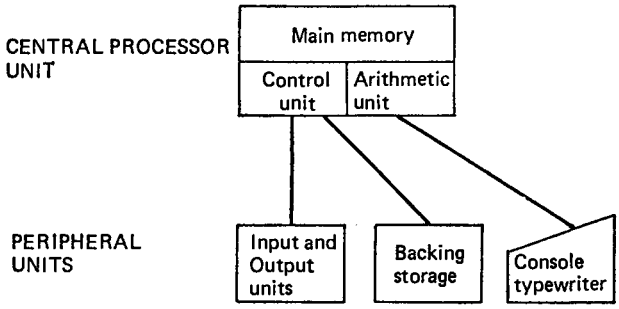

Fig. 1. The basic units of a computer.

Similarly, a computer has various parts. The major ones are shown diagrammatically in Fig. 1.

Central processor unit (*CPU*). The heart of the computer, comprising main memory, the control unit, and the arithmetic unit.

Main memory holds the data being processed, and also holds the instructions for doing the processing.

Arithmetic unit. This contains the circuitry for performing calculations. The basic calculations are add, subtract, multiply, and divide.

Control unit. This contains circuitry to monitor and control all the operations of the computer. It acts as an interface (or link) between the peripheral units and the main memory, and as an interface between main memory and the arithmetic unit.

Peripheral units are, generally speaking, anything connected to the computer that is not a part of the CPU.

Input and output units are electro-mechanical devices for getting data into the computer in the first place, and then for getting it out after it has been processed. Familiar examples would be a punched-card reader as input, and a printer or telex as output.

Backing storage is always necessary because of the size limitations of the main memory. Any data which will not fit in main memory can be written out to backing storage (in a form that is not readable by the human eye) and later read back in. These units are also input and output units, but specialised ones.

Operator's Console. A device to enable the computer operator, a human being, to interrupt the processing and give additional instructions to the computer. It is similar to an ordinary typewriter, but with extra keys and switches for special purposes, with a video tube often attached.

All of the peripheral units are connected to the central processor unit (CPU) by cables. In many computer installations, the cables run under a false floor, which has panels that can be removed. This keeps the wiring out of the way so people do not trip over it, but the removable panels allow the engineers to get at it easily for inspection, cleaning, and repairs. Plate 1 shows a typical computer installation with various types of input and output devices.

To summarise, the basic functions of a computer, performed by its various units, are:

1. Arithmetic such as add, subtract, multiply, and divide.
2. Transferring data from input units to main memory.
3. Moving data around in main memory for processing.
4. Writing data out to output devices.
5. Assessing instructions for processing.
6. Transferring instructions into and out of main memory.
7. Carrying out (executing) instructions.

Analogue versus Digital Computers

An analogue device is one in which data is represented by physical variables.

A digital device is one in which data is represented by numerical quantities.

Fig. 2 shows an analogue clock and a digital clock. Both are in common use today, and everyone has seen examples of each type. The analogue device can be thought of as showing the information desired as an *analogy*; the position of the hands of the clock is *analogous* to the time of day. The digital clock, on the other hand, shows the time of day as a set of numbers.

Similarly, there are two basic types of computers: those that operate as analogue devices, and those that are digital. Experience has proven that digital computers are much more flexible in the kinds of operations they can carry out. Digital computers are much more widely used today, and all standard business and scientific computers are digital ones. Analogue computers do exist, however, and are usually especially