CORE BUSINESS PROGRAM

BUSINESS DATA PROCESSING

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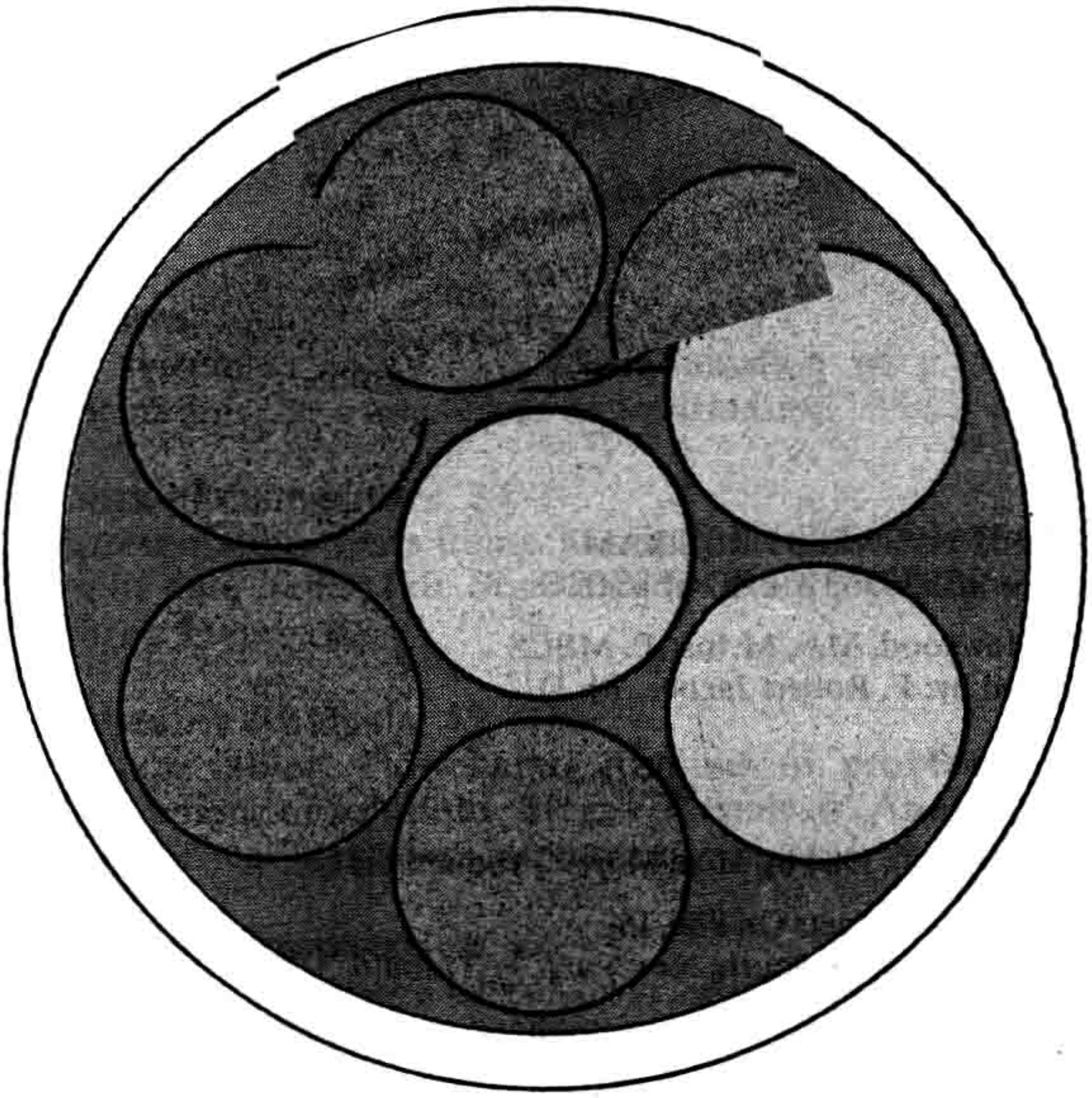

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Contents

Introduction

The transactions of business and the control of processes are accompanied by the storage and processing of information. The progress of technology has led to the development of a variety of aids to these activities. In particular, devices such as typewriters, calculators, mechanical accounting machines, and digital computers have been developed.

The electronic digital computer, for example, has decreased in cost and increased in speed to the extent that it has now taken its place in a great variety of different types of information processing. From being available to a limited number of people engaged in scientific and commercial data processing, computing has become a part of many professions. Today the digital computer has even become common in the home, where its tremendous educational and entertainment value are only beginning to be tapped.

The application of computers forces a logical analysis of the flow of information and the criteria for making decisions. These requirements have led to the development of a systems approach to analysis and use of information. Much of the success in the use of digital computer technology is dependent upon proper analysis of these requirements.

Computing cannot be studied in isolation from other topiics in business studies, since it affects many facets of a company from both a decision-making and information processing standpoint. This book is intended as an aid for all those studying computing as part of the many business disciplines which it assists. In doing so, it provides a compact statement of the core of knowledge required in computing. The reader is referred to the Further Reading section on page 118 for a list of books providing more detailed information.

Computing, in particular, is bedevilled by a profusion of technical terms, often with no uniformity in their usage by the different suppliers of equipment and services. The glossary on page 119, and several books in the Further Reading list, aim to clarify the terminology.

Chapter 1

Basis of Computing

COMPUTERS AND INFORMATION

Computing, printing, photography and sound recording are all forms of automatic information processing. In all of these processes, the information, as perceived by man, is captured, processed, transmitted and stored. Finally, it is reproduced in a form which can easily be understood by man.

The computer is a machine which automatically processes input **data**, in accordance with a **program** of instructions stored within the computer, and then provides the results in a useful form. The computer can combine several pieces of information in a preset way and provide a result different from the input, whereas the other forms of information processing mentioned above are generally attempting to re-create the input information. A distinction needs to be made between meaning and physical representation: information is the *meaning* which a human understands, whereas data are the *physical representation* of that information in a manner formalized for transfer to another human or machine.

Information is formalized when it is spoken or written, using the agreed sounds, letters, words and symbols of the particular language in use. In writing, strings of letters represent words and strings of digits represent numbers.

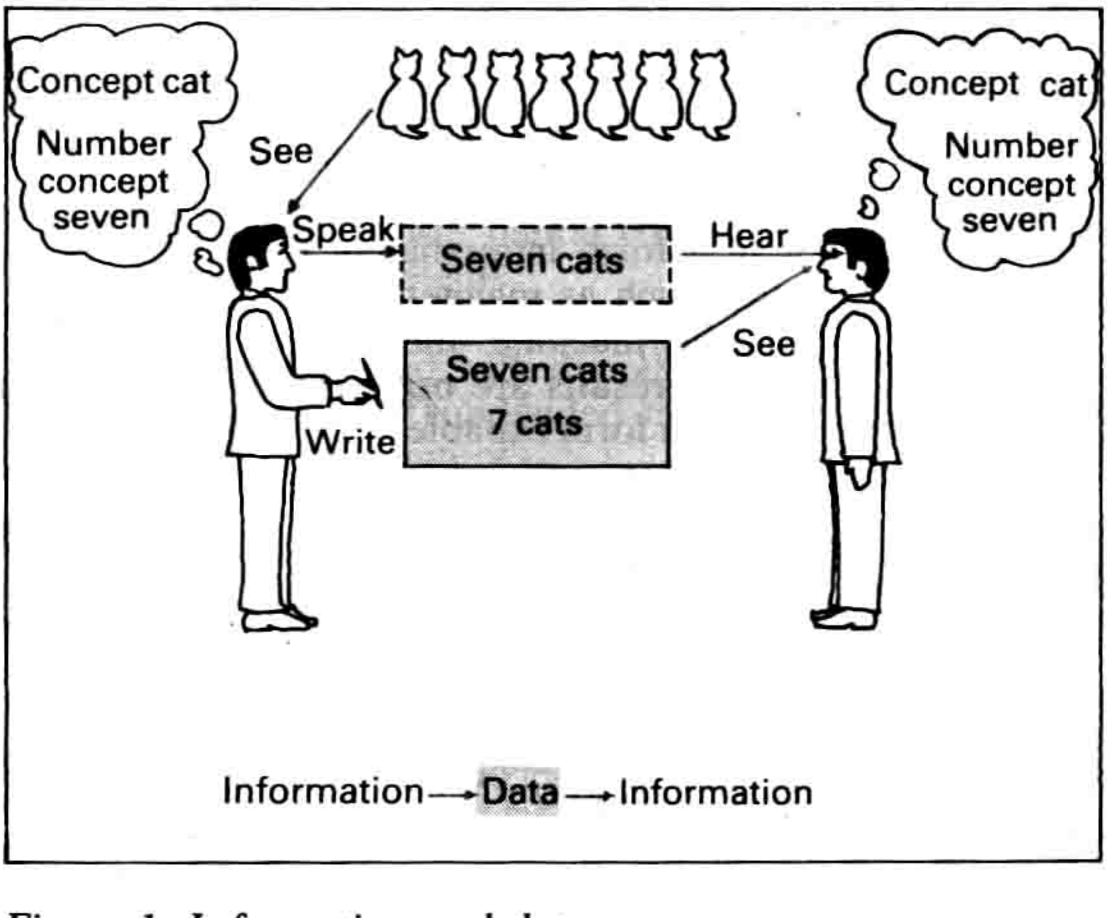

Figure 1. Information and data

Figure 1 shows the distinction between meaning and representation. One person asks 'what can you see?'. The spoken or written reply by the other person is 'seven cats'. In writing, we can spell out the number or represent it by the digit '7'. The syntax rules of the English language require that in this reply the number is placed first and the word cat is made plural by the addition of 's'. 'The seventh cat' would convey completely different information.

In information processing, the strings of data characters are manipulated while they are in the machine, without reference to their meaning. Data is sorted, selected and combined arithmetically or logically. To achieve this, the problem to be solved must first be analyzed and a detailed sequence of instructions prepared. This sequence of steps and decisions is called an **algorithm** for the solution of the problem; the equivalent sequence of instructions in a form which can be understood by the machine is a computer **program**.

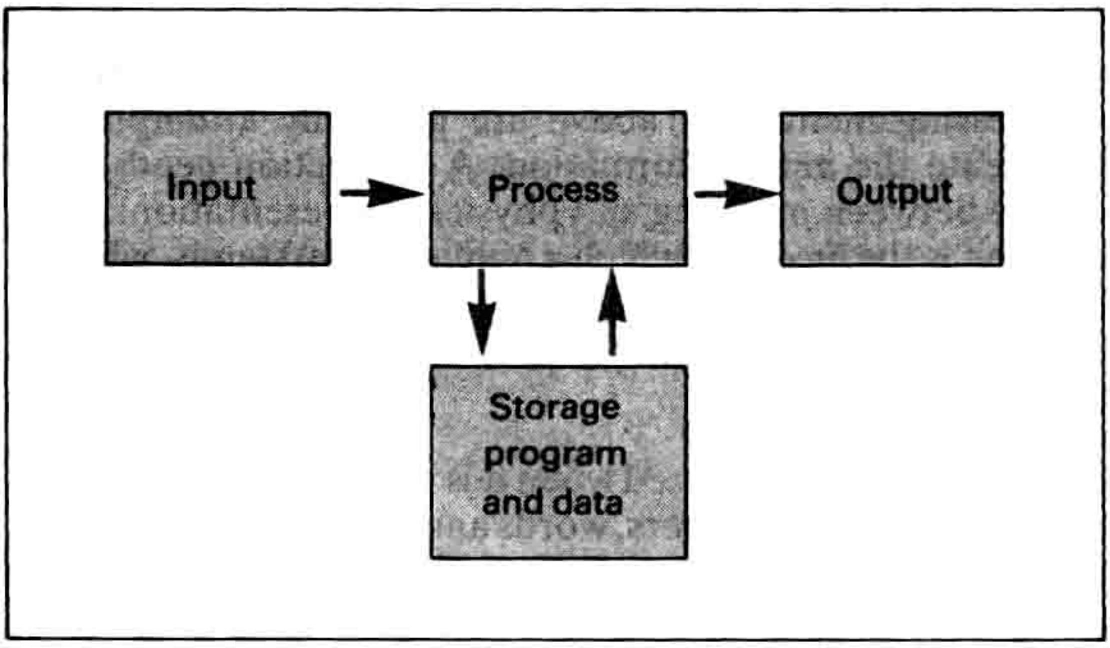

Figure 2. Elementary processes of computing

Figure 2 shows the elements of a computing machine. An input device passes data to the **processor** where it is manipulated in accordance with a **stored program**. Data may be stored either in a form immediately accessible, or by recording on media such as magnetic tape, which can be taken away from the machine and brought back when required. Finally, the results are **output** either in a form sensible to man, or in a form capable of directly controlling the operation of another machine.

The individual steps of a program (printed, for example) are simple. A step can carry out the following operations.

1. Perform arithmetic on numbers.
2. Perform logical comparisons of data items.
3. Choose which step to do next.
4. Move data around the machine – accepting input, storing, retrieving and providing output.

The following factors allow such simple steps to be built into the complex and sometimes confusing field of computing.

1. Speed Electronic computers perform thousands or even millions of instructions per second, with input and output up to thousands of characters per second.

2. Accuracy and repeatability Once the program has been written it is followed in the same way time after time.

3. High volume A computer may have access to any one of millions of items of data within a millionth of a second, and access to thousands of millions of items of data within a second.

4. Complexity The simple program steps can be built up logically into procedures which may be difficult for a human to implement manually.

5. Cost Mass production and economy of scale reduce the cost of information processing, since the same process may be repeated for many items of data, and the same types of equipment can perform many different processing tasks.

6. Environment Although some large computers require a clean air-conditioned environment, others are built to function in conditions inhospitable to man, e.g. space, missiles.

7. Commonality Complex procedures are common to many organizations, e.g. tax for payroll, so the same set of simple steps can be used in many instances.

Types of computer

Computers may be subdivided into the following categories.

1. Digital computers operate on numbers as strings of discrete digits.

2. Analog computers operate on numbers as physical magnitudes, e.g., of voltage or angular position.

3. Hybrid computers are digital computers incorporating analog processing elements.

This book is concerned with digital electronic computers. These can be further subdivided into special-purpose or general-purpose computers.

1. Special-purpose machines are tailored and connected for one application only, e.g., traffic control, automobile ignition systems, arcade 'space invader' machines, etc.

2. General-purpose machines can be used for a number of different applications including business, scientific, educational, leisure and a whole multiplicity of information processing requirements.

Special-purpose computers perform their specific jobs as need arises, but general-purpose machines can do many different kinds of jobs.

1. Transaction processing This involves the query and updating of data managed by the computer. The term is particularly used where a number of terminals have access to the same program and stored data, e.g., in airline reservation systems. If the result is given immediately the computer is said to work in **real time.**

2. Batch processing Inputs are gathered together from various sources within an organization. The same process is performed on all inputs as a batch, often during a time period when computer usage would otherwise be low. The results are distributed, e.g. payroll.

3. Multi-access Many users at terminals are able to develop and run their own programs with their own stored data. The programs run independently, but are all stored in one computer.

Communications

Communications links may be used to connect computers with users. This allows the results of processing obtained from one computer to be used as input for another computer situated elsewhere, and provides remote input and output of data to terminals controlled by users. The major communications lines currently in use are those of the telephone system. Organizations based at a single site can use local cabling. These local systems of computers are often formed into local area networks which allows users to share the resources of many computers.

HISTORY OF COMPUTERS

Computers have developed as a result of the needs of the people to process information. As people required more speed in information processing and greater data storage capacity, computer technology flourished. Development of computer technology has caused significant changes in the way society operates.

Incorporation of the technology into a business may change the mix of skills required in the organization, and may result in many people losing their jobs, thus creating negative feelings toward its further development.

Computing has features which tend to isolate it in social terms. Information processing by computer is organized and formalized in a manner which many people dislike and find alien. Jobs change in a way which alters not only the content of the job, but also the way in which people have to think. The computer and its attendants appear to have enormous power, which can be used constructively or destructively. However, understanding can dispel fear, and so it is necessary to consider the precursors of computers.

By 500 BC, a counting board with pebbles in grooves was in use in ancient Greece. A descendant of this board, the **abacus**–with beads on wires–was developed in China and Japan, and is still widely used in the Middle and Far East for commercial calculations. The abacus preceded the posi-

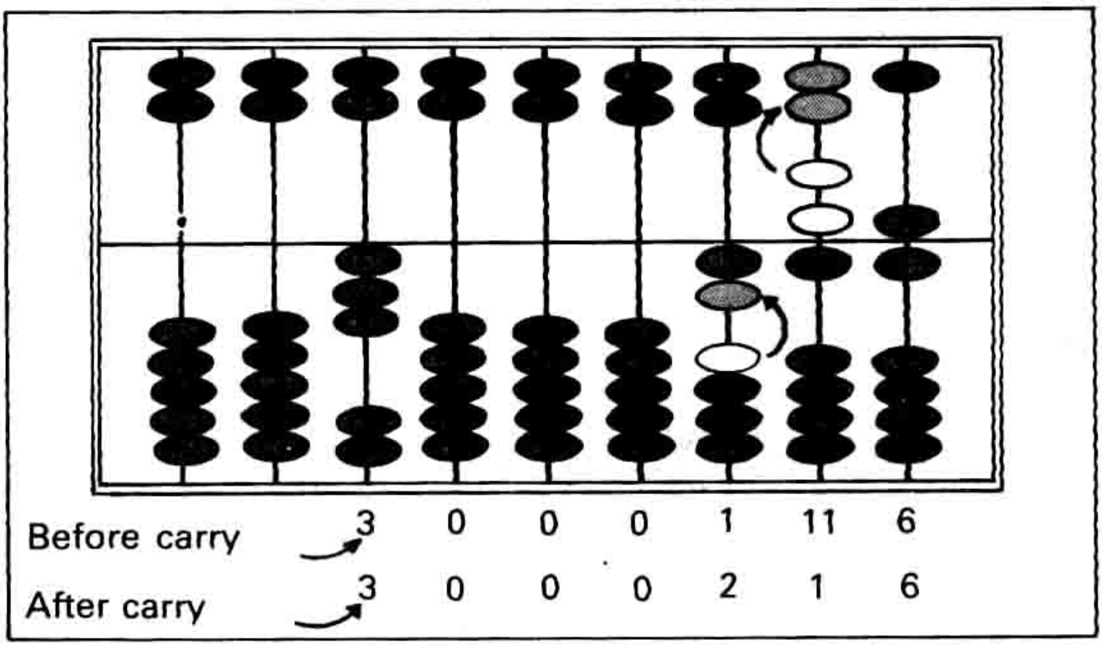

Figure 3. The abacus

tional numbering system and the invention of a symbol for zero. In the Chinese version, shown in Figure 3, there is a maximum of two beads above the bar and five beads below the bar on each wire. Each bead above the bar stands for five and each bead below the bar stands for one. The beads against the bar on a wire represent one decimal digit. Addition is performed by moving appropriate extra beads towards the bar, then making adjustments for any carry.

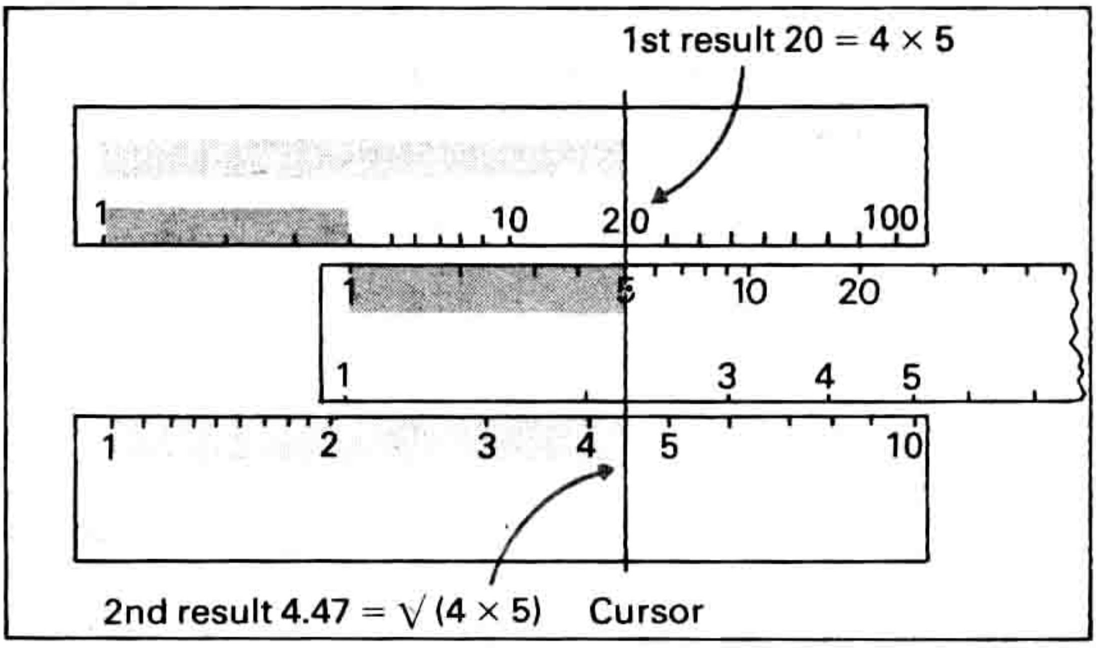

Figure 4. The slide rule

Napier (1550–1617) invented logarithms–numbers with the property that the sum of the logarithms of two numbers is the logarithm of their product. This allows multiplication and division to be performed by using addition and subtraction. By 1672 this principle had been applied to a calculating device–the **slide rule**. Ruled gradations are spaced logarithmically on two slides. Figure 4 shows the number 5 on the middle slide being multiplied by the number 4 on the top slide. There are two decades on the top slide and one on the bottom, arranged so that the number at any position on the top slide is the square of the number on the bottom slide, which allows the calculation of squares and square roots to be performed. With additional scales, and a fine line cursor across all scales, the calculation of trigonometrical functions became possible. Special-purpose slide rules were made for particular industries, for example, as photographic exposure calculators. The slide rule became the standard calculating tool of the scientist and engineer until pocket calculators became relatively inexpensive. The accuracy of a slide rule, however, is limited by the engraving and reading of the scale. Normally, it is not accurate to more than two decimal figures.

Accounting machines

Accounting requires accurate computation, not the approximations provided by the slide rule. In 1642 the Frenchman Pascal invented an adding machine with a set of eight toothed wheels, such that if the units wheel was moved on from '9' to '0' the carry was added to the tens wheel, and so on. A **'carry wheel'** mechanism is shown in Figure 5. Each decimal position has two wheels on a spindle, one with 20 teeth and one with 2 teeth. This allows the carry up or down, for addition or subtraction.

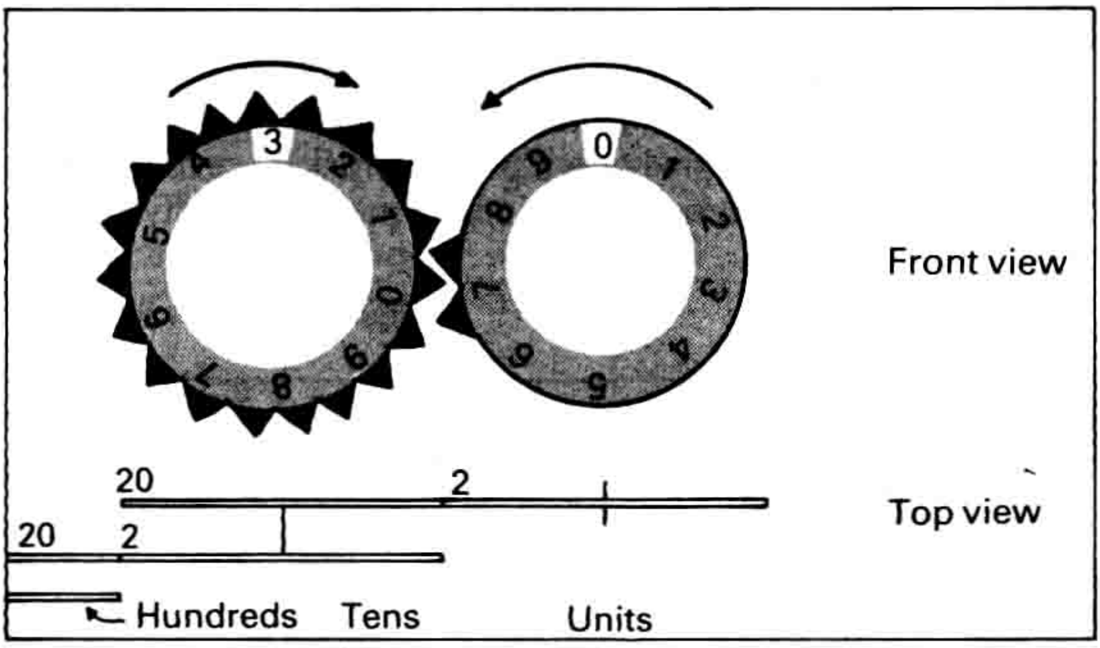

Figure 5. Carry wheel

In Germany, by 1704, Leibniz had added stepped wheels, allowing direct multiplication and division. These machines were mechanically complex, requiring both precision and strength. Initially, the machines built by Pascal and Leibniz were fragile and could not be made in quantity by the processes available at the time. However, technology soon caught up with the inventions, and accounting machines became the standard tool of European commerce.

These machines progressed in complexity and variety. Additional wheels or keyboards were introduced for initial setting of numbers. Other developments included wheels to accumulate running totals, printing on paper rolls or **ledger cards**. A typewriter keyboard allowed the customer's statement to be prepared and the supplier's sales ledger to be updated. The operation in this type of application was controlled by a **program bar**–a piece of metal with notches to control the sequence of operations and print positions of the mechanism. At the beginning of the transaction the operator keyed in the previous balance and account number. On some machines, methods of detecting errors in re-keying balances were incorporated, for example by adding the customer account number and balance. This **hash total** was recalculated at the beginning of a transaction and compared with the carried forward hash total.

Electronic accounting and visible record machines

As mechanical accounting machines developed, motors and relays were added and mechanical counting wheels were replaced by purpose-built electronic logic. **Magnetic ledger cards** also became available. The account number and old balance were recorded on a magnetic strip that ran down the card and were read into the machine as the card was inserted. These machines evolved into sophisticated accounting systems which could run at the local level of the organization and allow immediate management control. Their development continued in parallel with the growth of computing; as a by-product of ledger accounting, some machines punched **paper tape** which could be processed by computer for the provision of centralized management accounting. Electronic accounting machines are now merging into computing, with fixed logic being replaced by a **microcomputer** and ledger cards being replaced by **cassette tape** or **floppy disk**.

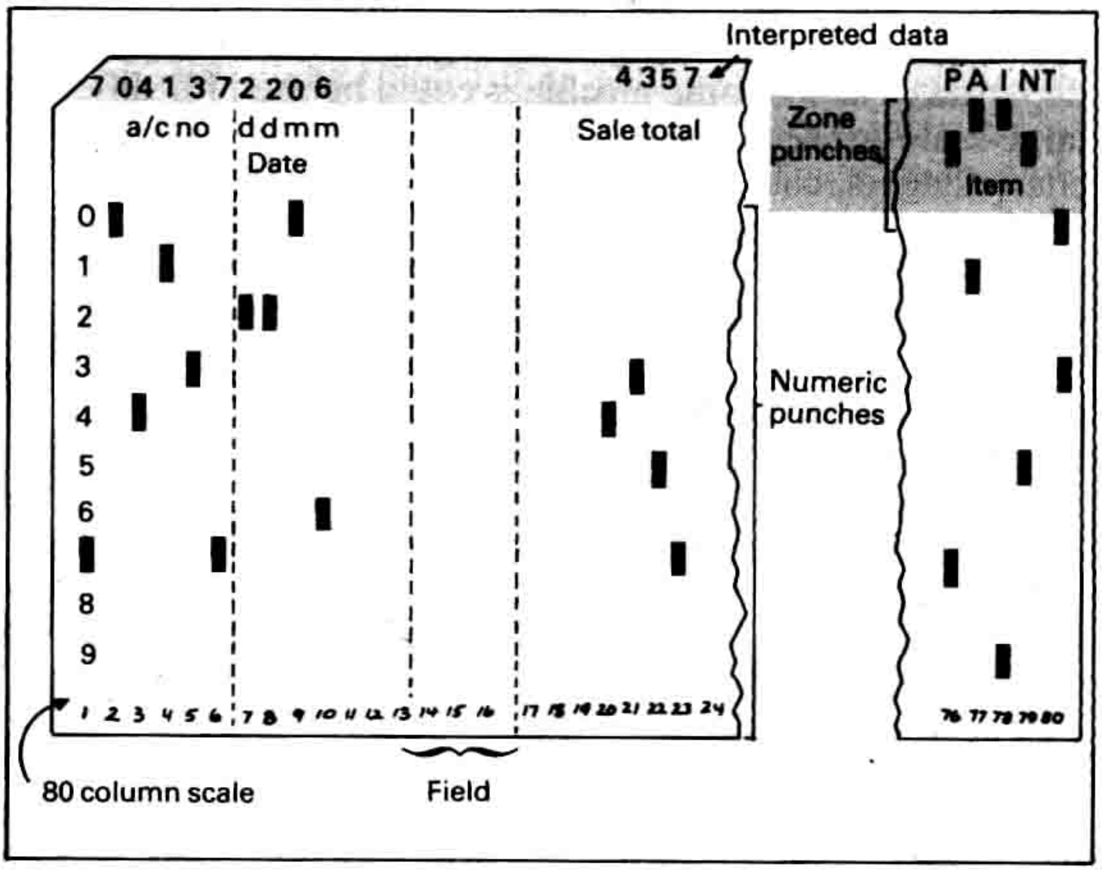

Figure 6. Punched card

Punched card systems

The weaving of complicated colored patterns requires the selection, in a predetermined order, of threads on a loom. In France, in the 18th century, Jacquard developed a loom in which the threads were selected by rods pressing through holes punched in cards. The pack of cards for a pattern could be stored for reuse. This system was itself a commercially successful method of machine control and in turn led to a method for the processing of high volumes of data.

It took over seven years to produce the first report on the 50 million inhabitants of the United States. Following the population census of 1880, the imminent 1890 census posed an interesting 'data processing' problem. A solution to the problem was developed by Hollerith in the form of an electromechanical machine which counted and tabulated cards encoded with data. For the 1890 census, the number and characteristics of people were encoded using a series of holes on cards. These are often referred to as punched cards.

Initially, the coding of information from a document to a punched card had become a separate operation from the tabulation of that information. Hollerith subsequently developed many machines for use in business. For example, the following type of activity could be performed. The **unit record** data of one business transaction was punched into one card. Cards could be sorted mechanically, placing all purchases by one customer together and collating them with cards containing name, address and previous balance. A **tabulator** printed a statement for the customer and punched a card with the new balance, ready for the next month's run.

Punched card processing required the use of a number of different machines working in sequence to **sort**, **collate**, **tabulate** and **reproduce** cards. It became economical to put all the data processing of an organization in one central department as the same machines could be used for different large-scale applications, e.g., payroll, invoicing, sales and purchase ledgers, cost accounting, inventory control, etc.

An administrative discipline developed to ensure that a card was punched correctly for each transaction and that no cards were lost. This formed the foundation of current **control procedures** in data processing. Documents would be batched, an adding machine would be used to form an independent total for the batch–for example, of the sales values–and the **control totals** would be checked throughout subsequent processing. After one person had punched the data of a batch into cards, a second person would repeat the process, using a **verifier** which marked any discrepancies between the two punchings.

Punch cards were particularly suitable as **turn-around** documents. For example, a card was punched with a magazine subscriber's account number and renewal date and, as the renewal date approached, sent to the customer, requesting a renewal. On receipt of the subscription the card was replaced in the addressing system to validate the subscription for another year. The convenience of physical sorting also led to the introduction of **aperture cards**, which could hold microfilm of engineering drawings and enabled cards to be sorted and selected as required.

Computing engines and computers

The origins of the computers themselves will now be considered. Babbage (1792-1871) was an English mathemati-