Data Processing

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Chapter 1

Introducing data

In 1754 a craftsman, M. Carpenter, made a dining table. He worked alone in a shed attached to his cottage, using timber he had cut from a tree felled some three years previously and left to weather in his garden. He sold the table to a local farmer living in the outskirts of his village and then made two written entries to record the sale—by adding the name of the farmer to the list of tables he had sold that year and by recording that he had received 15s. 9d. from the farmer in payment.

In 1983 a farmer visited his nearest town and from a furniture shop in the High Street purchased a table for use in his dining room. He paid for it by using a bank credit card. The total number of written entries relating in one way or another to the manufacture and sale of this table amounted to 295. These included entries recording the felling and processing of the timber in a plantation and sawmill in Canada; import and export documentation; entries relating to the manufacture of the table in a factory in the north of England, to its sale and delivery to a wholesale distributor in the Midlands and to its subsequent sale and delivery to the High Street shop from which it was purchased by its final owner. A further series of entries was made over the following few months as payment was made by instalments through the bank credit system.

Perhaps this simple illustration will help to highlight a few points:

(1) The dramatic increase in the volume of records generated as industrial and commercial activities have developed over the years, becoming, in the process, very much more complex.

(2) The need to devise formal routines, procedures and systems as a framework within which this mass of records can be effectively recorded and dealt with.

(3) That it has become impractical to cope with all these records by solely manual means and that recourse has been had to a range of mathematical and machine aids.

(4) The dependence of society generally in all its varied areas of

activity upon the information provided through these records for the effective performance of all of the activities and relationships with which we are involved today.

Recognising these points, this book has the following aims in view: to examine how and why these records originate, and how they can be organised and marshalled to provide the information essential to the successful running of the activities to which they relate; also to identify patterns through which this can be accomplished and to review techniques for ensuring the continued accuracy of the records being handled; furthermore, to discuss how mechanical and other aids of one type or another can be used to help in these processes.

Before enlarging on these points, it would, perhaps, be best to note and explain some of the terms we shall be using throughout this book.

Data

'Data' is the term given to all the facts and figures that are generated by and that record an event, an activity or a situation. As isolated facts and figures they may not be meaningful in themselves, but they can be marshalled and processed in various specific ways in order to give them a useful meaning.

Now, the simplest of our activities can produce facts—items of data—relating to it. If, for instance, we walk down to our local shop, two of the data items generated could well be: (1) the distance we have walked, (2) the time taken to walk this distance. As isolated items of data these may mean very little to us, but if we wanted information on the total distance walked during a week in order to see whether we had met a predetermined target for our quota of exercise over the period, then by adding item (1) to data collected from other walks we had taken we would finish up with information that would enable us to make a judgement on the effectiveness of our exercise programme and, indeed, could well influence our future actions by, perhaps, leading us to a decision to take a longer walk tomorrow. Also, should we be aiming to achieve a given walking speed in miles per hour, then by relating these two items of data we could compute the speed at which we had walked and so produce information to compare with our target.

To apply this argument to a commercial situation, if we were concerned in making the table mentioned earlier, we might well finish up with the following items of data:

(1) Eight 2 m lengths of timber were used, each 30 cm × 3 cm, and four 1 m lengths, each 12 cm square.
(2) The cost of the timber is £2.75 and £3.50 per metre, respectively.
(3) A. Carpenter worked for seven hours making the table.
(4) A. Carpenter was paid at a rate of £2.25 per hour.

Each of these data items as it stands means very little. To convert them into useful information it becomes necessary to subject them to various processes—for example, to associate the quantity of each type of timber used with its unit price and then to carry out a calculation by multiplying to find the cost of the timber used. The application of these processes to data is called *data processing.*

Data processing

Data processing embraces the techniques of sorting, relating, interpreting and computing items of data in order to provide meaningful and useful information. For example, the above data items when suitably processed would provide the information that the direct material cost of the table was £44.00, that the direct labour cost was £15.75 and that the total direct costs of making the table were therefore £59.75.

However, it will be evident that to arrive at these figures the data must be processed according to predefined procedures and rules arranged in a specific order. It would, for instance, be pointless to add the number of lengths of timber to the number of hours worked—the answer would be a nonsense. We first have to relate the length of a piece of timber to the number of pieces used and then compute the total quantity for each type of timber; this, in turn, must be related to the metre cost; and so on. In other words, we must work to a series of defined logical steps designed to give the result we are looking for.

Data processing system

The term 'data processing system' relates to an assembly of these steps in logical order, defining the instructions and procedures that must be applied to the data items at each stage so as to obtain the useful and meaningful information the system is designed to produce. Essential features in such a specification would be the identification of data items that have to be associated with each other,

the specification of calcuiations that have to be made, and showing how the resultant computations should be marshalled together and how the final results should be presented.

Information

Perhaps, at this stage, it would be best to look at information from two points of view. On the one hand, information can be said to be the product of a data processing system. As we saw above, by processing items of data generated by an activity according to defined rules, useful information can be obtained. On the other hand, information can also be regarded as an essential requirement to the pursuance of an activity. Doubtless, before the table we have been discussing was produced, it was necessary to provide some information regarding its design and structure—probably in the form of a technical specification. We can see in all of this a cyclical process (Fig. 1.1): an activity generates data; data items are subjected to defined rules and procedures known as data processing; data processing produces useful information; and this information, in turn, controls, influences or determines the activity.

Another rather arbitrary distinction we can make at this stage between two categories of information is as follows:

Operating information consists of information needed for and produced by the day-to-day running of a business. For example, information produced from data relating to the table mentioned above could take the form of an invoice to be sent to the purchaser of the table.

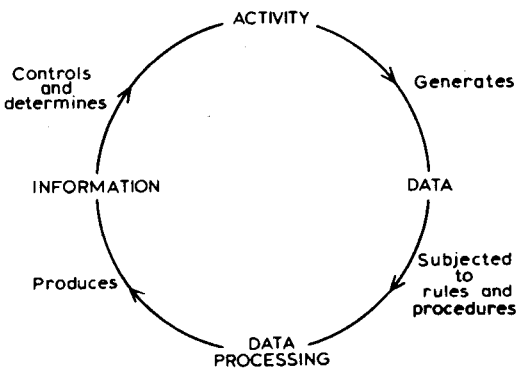

Fig. 1.1. The cyclical process

Management information is the information accruing from a data processing system and made available to management upon which decisions can be based relating to the overall conduct of the business. It may, for instance, include the total value of all the tables sold over a period of time, to enable profitability to be assessed and decisions arrived at to guide manufacturing activity.

At this point we can enlarge a little on the four points made earlier in this chapter, the first of which was connected with the volume of data.

Data: where from?

It will be evident that as the range and complexity of the activities with which mankind is involved have increased, so the volume and complexity of data generated by these activities have similarly increased. Some of the main areas in which, over the years, a dramatic escalation has taken place are now listed.

Personal data. In early years little or no recorded data existed on individuals. Identities were a matter of only local concern, with names often associated with the trade people pursued. By and large, trading activities were limited to the exchange of goods on a barter basis. As society developed, an ever-increasing range and volume of data relating to people, their possessions and their activities became necessary. An early example of this was the compilation 900 years ago of the Domesday Book, containing data resulting from a nationwide survey of land ownership. From the first rudimentary data held on people—formal names and addresses, birth and death dates, etc.—record keeping has progressed until today the list of the aspects of our lives on which data records are held is almost endless: income tax records, health records, employment records, motor tax records, insurance records, to name but a few.

Business and trading data. We have already noted that the earliest form of trading—barter—generated little or no recorded data. However, each subsequent development in industrial, trading and business activity brought in its wake more and more records. The introduction of currency led to the keeping of data on commodity values expressed in currency, as well as records of the flow of currency in and out of a business. Credit trading further expanded the range of data records, with the need to keep account

of debtors and creditors, and eventually comprehensive book-keeping systems appeared. As businesses grew in size and complexity, the importance of effective management skills became apparent, and with information the basic tool for exercising these skills, the generation and processing of data on all aspects of business activity became essential.

Technical and scientific data. Starting off with the need to record accurate measurements of physical properties (sizes, weights, volumes, etc.), invention and innovation in these areas has progressed at an ever-accelerating rate. Not only has this resulted in a dramatic increase in the range and, therefore, the choice of available products and processes, but also it has carried with it the need for increasingly complex specification. For example, the volume of data relating to a penny-farthing cycle of 80 years ago bears no comparison with that generated in the design and manufacture of an aircraft jet engine today.

Legislative data. Again, the past century or two has seen a vast increase in the volume of data called for by both central and local government from both individuals and businesses. Some well-known categories are census records, voting register records, income tax records, police records, etc.

All in all, when we compare today's businesses with those of only 100–200 years ago, we find an almost phenomenal increase in the amount of data that is generated and has to be stored and processed both for internal administration and to meet external demands.

Data: types of record

If we take an overall look at the records with which a business will be concerned, it is possible to break them down into a number of fairly well-defined categories (Fig. 1.2) as follows:

(1) Those flowing into the organisation from external sources, such as purchase invoices, delivery notes and cash receipts.
(2) Records generated by the day-by-day internal activities of the business—for example, the amount of material used on a specific job, the number of hours taken to accomplish a given task or the cost of heating an office.
(3) Permanent or semi-permanent records needed for reference

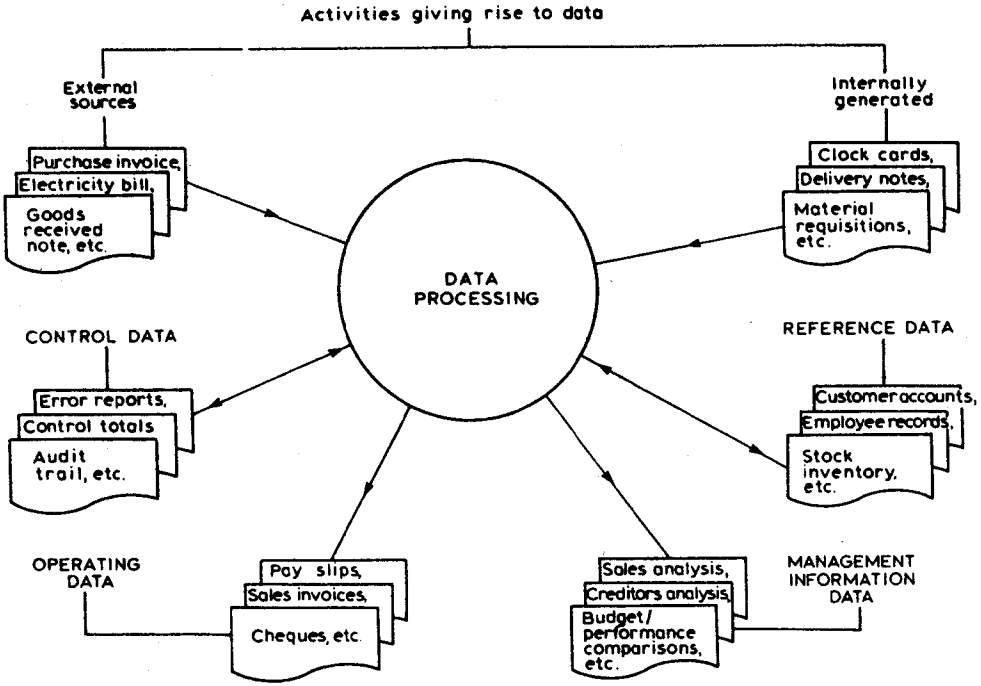

Fig. 1.2. Types of data

purposes, of which customer accounts, employee records and price lists are examples.

(4) Operating records for distribution, such as sales invoices, remittance advices and payslips.

(5) Information for management control purposes—for example, cash flow statement, analysis of total sales, performance/budget comparisons.

(6) Control information to ensure accuracy and timeliness of the whole procedure of keeping and processing records. This will include such things as error reports, audit trial, etc.

Thus, we have records flowing into a business, records generated by the business activity itself, reference records and output records (usually known as reports) resulting from an interaction of the first three. As we have seen, the mechanics of the interaction of these records is data processing and the assembly of the list of instructions in a logical format that will accomplish the aims we have in view is known as a *data processing system*.

Data processing operations

We shall be looking at these in more detail later on, but we can at this point summarise the main operations that are likely to be encountered in a data processing situation.

(a) *Recording*. The process of *writing* the data relating to a situation on some form of recording medium. This may be in ordinary characters or in coded form. It will be performed in accordance with the rules specified by the system.

(b) *Analysing*. Grouping together recorded data items relating to the same function—for example, sales invoices, credit notes, delivery notes, etc.

(c) *Sorting*. Arranging data items within a group into a logical sequence—alphabetical, numerical, etc.—by record key.

(d) *Collating or merging*. Associating together data items relating to a common record—for example, the master sales ledger record and the sales invoices relating to it.

(e) *Calculating*. Carrying out arithmetic processes on related data items—for example, multiplying the number of articles by their unit price to find the total value.

(f) *Comparing*. Testing one data item against another in order to determine a course of action—for example, comparing actual stock with minimum stock level to decide whether to reorder.

(g) *Matching*. The process of checking that the identifying elements in related data items are identical.

(h) *Verifying*. Checking to verify the accuracy of recorded data, calculations, etc.

(i) *Filing*. Storing data records for future reference in a logical or known sequence so that they can be readily located.

(j) *Retrieval*. The process of selecting and extracting data records from file that are required for use in the processing routine.

(k) *Updating*. The process of keeping master data records up to date by the application of movement data items.

(l) *Rearranging*. Assembling data records in the order and the pattern required for any particular purpose such as output reports.

(m) *Communicating*. The process of preparing output records in a manner that will be understandable to the user.

(n) *File maintenance*. The deletion of records no longer required and the insertion of new.

Data recording and processing in practice

How these types of data record (1–6 above) and these basic data processing operations (a–m above) work out in practice can be illustrated by the following example.

Say you were to start up in business on your own as a mechanic repairing cars. On an approach by a prospective customer you would prepare an estimate for the job and then, on its acceptance, would carry out the work, presenting your customer with an invoice for payment on its completion.

Before starting work you will obviously have to buy in a few supplies—say motor oil, a few commonly used spare parts, some cleaning materials, etc. Records you will receive as a result of these purchases are delivery notes and purchase invoices (1). At this point you may decide to keep a record of the supplies you have received—for example, the number of litres of oil delivered, the cost per litre, and the name and address of the supplier (3). You will probably use a separate piece of paper for each product, keeping the papers together in a folder as a file (n). In fact, you may decide to open files for the delivery notes and the invoices as well (b). Within these files you will keep the records in alphabetical order to facilitate easy reference (c, i).

While working on the job, you will keep a record (a) of the time spent on it (hours worked) and a list of the materials used (2), adding the customer's name to each entry to identify the job. On

completion of the job you will want to work out how much it has cost you.

To do this you may prepare a cost sheet bringing together all of the items of cost (d), checking as you do so that the same customer name appears against each item (g). You will now evaluate these items of cost, retrieving from your file (j) the prices of the materials and noting these down on the cost sheet and also the hourly rate you are going to charge for your labour. Next some calculations will have to be carried out involving multiplying the quantities by their unit price (e). The sum of the products will then give you the total cost.

Having done all this, in order to be on the safe side, you could well check that every record made during the job's progress has been dealt with, check that you have used the correct prices and also check that the calculations have been carried out correctly (h).

Two other things you may do at this point. You may look up on your file the original estimate and compare this with the total cost you have just arrived at (f). This will give you some idea of the effectiveness both of your estimating procedure and of the job performance. You may also at this point check the balance of, say, the motor oil that remains in stock and review this against the quantity you know you are going to need to see you through to the next delivery (f) and so decide whether you should now place another order for a fresh supply.

With the total cost now known and with reference to your estimate, you will now be able to assemble together (l) the information required to prepare an invoice (4) for presentation to your customer, typing or writing it in a way that can be understood (m).

Inasmuch as your customer will now owe you some money, you will doubtless want to keep an account of what is owed; indeed, you will also want to keep records of money you owe to your suppliers. On sending the invoice to your customer, you will post the amount to his account, adding it to any balance already outstanding and so bringing the account up to date (k).

Periodically, perhaps once a month, you will want to review your business activities. You could do this by arranging and analysing the records you have kept so as to show the total turnover and profitability of the different categories of work you have been engaged in (l), such as repainting, mechanical repairs, servicing, etc. You may use this information to arrive at decisions (5) to discontinue servicing because this is unprofitable and to concentrate in future on repainting jobs because it is in this area that your profit level is highest.

Finally, during the whole of this process of recording facts and figures you will want to monitor that work is keeping up to schedule and that all your records are kept up to date and are accurate—for example, by checking the accuracy of invoices received for supplies and notifying your supplier of any discrepancies (6).

Data processing methods

In the example given above we have assumed that all operations were carried out manually. Of course, in practice, this is seldom the case. As we saw earlier, the volume of records flowing through an organisation is usually so great that mathematical and machine aids of one kind or another have to be relied upon to deal with them. These devices will be reviewed in some detail later on, but the main agencies through which data are processed are summarised below. It would, of course, be wrong to assume that only one of these is used exclusively in any specific data processing situation. In practice elements of them all could well be present.

Manual processing involves the use of mainly handwritten or typewritten records but will usually incorporate the use of ready reckoners, slide rules, calculators, etc., as aids to performing arithmetic.

Mechanical aids. This term generally means the use of mechanical or electromechanical devices such as accounting machines, punched cards, keyboard entry devices, etc.

Electronic aids. This term covers the whole range of electronic computers and calculating devices.

While the data processing operations listed earlier are common to all of these methods, it will be evident that the use of machines, particularly computers, will involve some additional operations, such as:

The *preparation of data* in a form that can be accepted by and worked on by the machine.

The imposition of a comprehensive set of *controls* and *checks* to ensure the accuracy of data items while they are being processed and also that the machines used are functioning properly.

Assembling and communicating to the machine a logical sequence of instructions—a *program*—that will specify the functions it must perform in order to carry out the processing operations required.