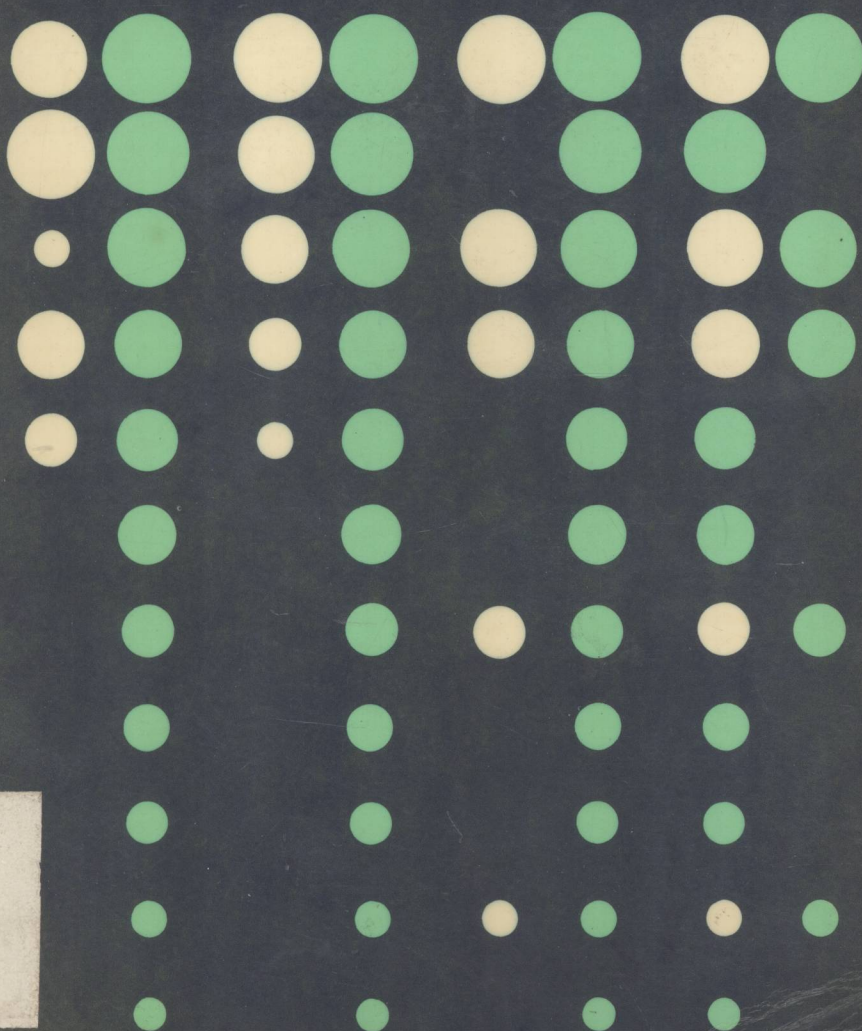# Data Processing
and
Computer Studies

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Data Processing and Computer Studies

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Processing and Computing

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Preface

This book provides useful material for the many computing and data processing modules appearing in a variety of syllabuses. In particular it is intended to cover the Computer Studies and Data Processing modules for the BEC National Awards. For the convenience of such students a table indicates the corresponding learning objectives from each syllabus. This will be particularly useful when choosing appropriate sections for assignments, and for revision purposes.

With the increasing numbers of microcomputers in the office and the home more and more people will require the knowledge of computers and their application which this book gives. The author's career has involved working in business, working with a computer manufacturer, and teaching. This blend of experience ensures that the balance between theory and practical application is maintained. The author is at present a senior lecturer in data processing and computing. The daily contact with students which this involves has promoted an understanding of areas which they find difficult.
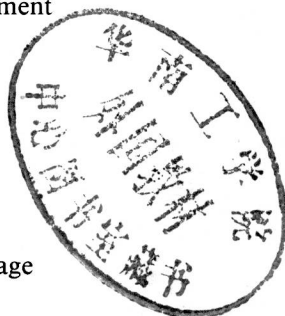
The author is a member of the British Computer Society, the Institute of Data Processing Management, and the British Institute of Management.

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Table of learning objectives for BEC National Modules and relevant sections of text

1 Information

1.1 The need for information

The need for information is not confined to business, industry or government. We all require to know things all the time. The task of picking a team of athletes needs information about fitness, experience and recent performances. During the first few athletic meetings not enough information will be available to produce reliable figures. Other information, such as the all-round ability of an athlete will influence our choice. In the latter part of the season we need to be able to recognise athletes who are currently in form and better than their performances suggest, as well as those who made a good start to the season and have not done so well lately. What we are doing is taking various sets of facts and figures and trying to relate them to each other in a meaningful way. The result of this process is to produce information on which decisions can be made. Naturally we have to do the best we can with the data (that is the facts and figures) which is available to us. We may not know that our opponents have just acquired a new member. It may rain unexpectedly just before the meeting and produce the sort of track which does not suit the team we have chosen.

Bus, train and airline timetables are another type of information. These enable us to plan journeys, so that we know when to set out and where to change in order to reach our destination by a certain time. On a long journey there may be several alternative ways to travel. We need to know about fares, facilities for meals en route, and the degree of comfort on the journey before deciding which way to travel. We can sort through this data and produce information which will tell us which methods meet our requirements in terms of cost, journey time and so on. From this information we can decide which route to take. Of course, the coach may break down, or the plane may be delayed. This is a chance we have to take because there is no way of knowing in advance whether this is going to happen. All we can do is to pick a reliable operator, or, if the price is too high, we must realise that hold-ups on the journey may be more likely if we pay less to travel by an alternative method.

Sometimes we are concerned with activities which involve working out costs - the firm's annual outing, for instance. There is the cost of

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hiring the coach, booking evening entertainment and so on. These costs have to be divided by the number of people taking part so as to give a cost for each person. To this must be added the cost per head of a meal. So we have fixed costs and variable costs. The coach is a fixed cost. It remains the same whether the coach is full or not. The meal is a variable cost, as the total amount is in direct proportion to the number of people involved. If employees have to say in advance whether they are going on the outing it is relatively simple to work out how much each must pay. Selling a similar trip to the general public involves taking a decision on how many people are likely to buy tickets. If the price is too high not enough people will buy tickets to cover the cost of the coach and the entertainment. If the price is too low more people may come but the number needed to cover the costs will be greater. Again we are faced with making decisions, and without information to guide us this task would be impossible.

Running a small business, a corner shop or market stall, for example, requires more difficult decisions. There are many items to buy and sell; even a small shop may stock 1000 different lines. To be successful we need to know which are selling well so that we are never out of stock of these. We need to anticipate demand. In summer, sales of chocolate confectionery will fall, and sales of ice-cream and soft drinks will increase. Instead of selecting our best team from 20 or 30 people we now have to choose 1000 lines from perhaps 5000.

We shall need to consult price lists and compare products in the same way that we look at a timetable and choose a suitable bus or train. Other factors such as the profit we make on each item, product advertising and attractiveness of packing must be taken into account before we buy. The destination of our journey has become a profit to be achieved.

Finally we must decide whether we can make a profit after all expenses have been paid. The rent and rates remain the same whether we sell very little or a great deal. The gross profit which we make from selling our goods could easily be used up by these fixed costs, leaving us with little or nothing by way of profit. Perhaps we need to look more carefully at items with low profit margins to see if they are worth the time and space needed to sell them.

In small businesses the scope for trading is limited. Customers will be local and their needs will be reasonably well known. The bulk of the stock may have to come from a local 'cash and carry' wholesale store so that small quantities of each item can be obtained. This limits the choice of items which can be sold to those which the 'cash and carry' store keeps. If the demand for an item falls away unexpectedly it may be that another store is selling it more cheaply. A quick walk around the neighbourhood will soon establish the amount of competition, and the prices at which things are being sold. Once the stage of a one-man business has been passed the amount of information required can no longer be controlled and organised by one person. Twenty shops will produce twenty different patterns of demand. What sells well in one may do

badly in another. There are twenty different lots of competition to consider. Buying requirements need large quantities which manufacturers will be prepared to deliver. Instead of price lists from two or three local 'cash and carry' stores, it is necessary to study many price lists and catalogues. There will be some central administration, maybe a central warehouse, making yet another expense to be considered when costing.

Cheap transport and modern manufacturing methods have dramatically increased the possibility of trading outside one's own locality. The amount of information needed to run a business has increased correspondingly. A car manufacturer must know about the international market for cars, and must be aware of competition on a world-wide basis.

Yet the three examples we looked at first – athletes, timetables and the firm's annual outing – still have a close parallel in the business world although in that world the amount of data to be looked at is many times greater and the processes of turning the data into useful information are infinitely more complex. The type of information needed to select an athletics team is similar to that used by a stock controller to decide what items need to be purchased to replace those used up. The information required for this job is the average usage over the past weeks. In the same way as the team selector needs to know if the team members are out of form or just coming into form, so the stock controller needs to know if demand for a particular item is rising or falling. With this information he or she can decide whether enough of an item is still in stock or if an order needs to be placed for some more. This latter decision involves having other information, such as the length of time it will take for the new stock to arrive. A company may hold stocks of 10 000 different items all of which need to be examined at frequent intervals if supplies are not going to run out. 'Stock-outs', as they are frequently called, make it difficult for the workers who rely on a regular supply of components to keep to a production schedule. As a consequence the factory cannot operate at full capacity. Choosing an athletics team could be considered a pleasant hour's task and selecting the wrong people involves nothing more than dismay at losing a meeting. Keeping the correct levels of stock is an arduous and responsible job with the prospect of financial loss if it is not carried out properly.

The example of the use of timetables leads us to consider the large number of statistics produced by private organisations and by governments. Some appear daily, such as currency exchange rates and commodity prices. Others, such as a whole range of economic indicators, appear monthly, quarterly, or annually. Yet others, such as the census appear rather infrequently (every ten years) so that the information provided may be out-of-date. Using these tables enables an organisation to study trends, to make comparisons with similar companies in the same industry and to examine figures for other countries. The use of

these tables of statistics is time-consuming and a great deal of calculation and sorting is required to produce relevant figures. Yet it is essential for such information to be available to management if sensible decisions are to be made about the future plans for the company. Correct costing of products and services is essential if profitability is to be achieved. The costing department in an organisation has to consider many factors. There will be a wide range of fixed costs, ie costs which remain the same however many items are produced, such as rent and rates on a factory building. Other costs such as heating and light will also be incurred. If many different products are made it will not be possible to determine exactly what proportion of the heating and lighting bills should be charged to each product. These items of cost are known as 'overheads'. In many cases the costs of administration, including the computer department, are regarded as overheads. Other items of cost are easier to determine. If one product uses a square metre of aluminium sheet then we can say exactly what this has cost. Ten items will require ten square metres, twenty will require twenty square metres, and so on. Such costs are known as 'variable costs' because they vary in exactly the same proportion as the number of items produced. Of course nothing in business is really simple. If we make several products from aluminium sheets and cut our requirements from large sheets what is to be done with the cost of the oddments left over which cannot be used for anything? And how shall we charge out the wages of the person who cuts up the large sheet into usable pieces if he or she does this job for all our products? One company may make thousands of relatively simple items each consisting of just a few parts. Another may make some complex item such as a jet engine. The output of jet engines per month may be small, but each one is made of thousands of components. In either case, costing is a much more complicated task than it is for determining the costs of the firm's outing. It requires a great deal of information to be provided if it is to be done correctly, yet in principle the same type of facts have to be collected and analysed.

Summary

The growth of businesses over the past 150 years from local to regional, national and then international enterprises has vastly increased the amount of information needed to run them. Although the problems have remained the same the number of factors to be considered has grown enormously. Without the proper information on which to make decisions no business can expect to succeed.

1.2 The information needs of a business

Very few sections of a company can work in isolation from the rest. The

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data needed by a department to enable it to carry out its work will come to it from many sources, and in turn it will provide data about its own activities that will provide information to enable other departments to operate efficiently.

The stock controller cannot begin the task of ordering fresh supplies of components or raw materials unless he or she receives data from many other people. In the first place the stock controller needs to be able to maintain a record for each item of stock which the organisation uses. How many of each item are in stock can be ascertained by physically counting them. This is laborious and quite impracticable except in a very small business. Of course there is a need to count them periodically to make sure that the records have been correctly maintained but, in between these counts, the records will be kept up-to-date by data from many sources. For example, the factory will send in requisitions for the parts it requires to make the company's products. The stockroom manager will advise the stock controller when the materials have arrived. These reports will enable the stock controller to know at any one time when stocks of an item are getting low and are likely to need reordering.

Before placing further orders additional information is needed. From the sales department the stock controller will need an analysis of sales. The components which are going to be in particular demand over the next few weeks or months can be ascertained so that extra quantities can be ordered. Conversely some items in stock may no longer be required in such quantities as in the past so that although present stocks are low there is no urgent necessity to obtain more. Failure to receive this type of information will mean that money has been spent unnecessarily on overstocking, or that orders for fast-selling lines will be lost because not enough stock of components to make them was ordered.

Despite all that can be done to avoid being out of stock of components or raw materials, it is inevitable that this will occur occasionally. When it does, the production of goods from the factory will be disrupted until the components become available again. The stock controller should be in a position to pass data on to the production manager who can take steps to alter production schedules. In this way the production manager can, perhaps, avoid the expense of idle resources.

As we saw in the previous section, the task of costing is very complex. In order to provide a proper cost for each item the costing department will need a great deal of data from other sections of the organisation. We have already seen that rent, rates, heating and lighting must be taken into account. The data will come in the form of bills from the local authority and the electricity and gas boards. Finding the cost of administration needs data from the personnel department about wages and salaries of the people doing this work and the personnel department must separate it from the wages paid to the production workers.

From the production manager the costing department will need

details of the wages paid to assemble an item, in the form of hours required to make it, and the grade of workers needed for each stage of its manufacture. In addition to wages there will be the machine costs. These again will take the form of the number of hours or minutes at each machine, and the cost per hour of running that machine. The costing department will also need to know about scrap material, and the percentage of items made but rejected as substandard. Perhaps the scrap and rejects can be sold, in which case the costing department will need data from another section of the company which is responsible for these sales.

Only by collecting together all this information from many parts of an organisation can a proper cost be established. This costing must then be passed on to the sales department, or whoever is responsible for setting selling prices or sending quotations.

None of these activities can be carried out unless each section understands the importance of the data it provides to the other parts of the organisation. In addition to collecting the data together, each section must arrange to make the data available to the people requiring it at the time it is needed. Without a realisation of the interdependence of its sections and departments on each other no organisation will operate efficiently.

This efficiency will only be achieved if data flows through an organisation in an orderly manner. These flows of data constitute the basis of what is known as a management information system. Every business, however small, has a management information system. In large organisations the provision and maintenance of a management information system may well be the responsibility of a specific department. Two particular problems arise in providing an adequate system. The first of these lies in establishing properly what information is needed by whom, and when it is required. This is an area which needs careful analysis. Not only must the information be made available but it must also be in a form appropriate to the recipient. Additionally, it must be there by the time it is needed for the purpose of decision-making. In many organisations much information goes unused because the persons to whom it would be of value are unaware of its existence. In other cases the information arrives too late to be of any use in the decision-making process. In making an analysis of the information requirements both these aspects must be taken into account.

The second problem arises in providing the information requirements which have been established by the previous analysis. Much data from outside the organisation will not be readily available or indeed may be impossible to obtain. It would clearly be invaluable to know the plans of industrial competitors but it is highly unlikely that such information will come to hand. Many official statistics are published and can be readily consulted. Although these may prove useful they may not be sufficiently detailed to permit the actual information required to be derived from them.

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Data arising from within the organisation should always be available although this is by no means the case in many organisations. To help this situation some companies with computers have set up a 'database'. This means that all information within the organisation is consciously gathered into a single unit with the object of making it available to anyone who needs it.

The task of each separate section of the company is to process its data not merely to achieve its own purpose but also to pass on to other sections the information they require. As we have seen it is not always possible to produce exactly what is required because some data will be missing or not in the desired form. However every section should set up specific procedures for achieving, as well as it can, the information requirements as they have been identified. Such a task needs a very clear definition of what results are to be produced, where the initial data for creating these results is to come from, and what processes are to be carried out to achieve the desired result. The job of specifying clearly and unambiguously what is required will be undertaken by a systems analyst whose duties are explained in more detail in Chapter 7. To carry out the task effectively he or she will need to enlist the co-operation of someone familiar with the work of the section under consideration. In this way a practical and effective system can be evolved which will both meet the requirements of the user and make use of the capabilities of the computer.

Summary

No organisation can function properly without a supply of data to give the essential information for decision-making. Data is frequently used for different purposes by different departments. It is essential that data and information should reach the people who need them quickly and in the correct format. The flow of data through a company constitutes its management information system. The use of a database ensures that data is made available as widely as possible within an organisation. A computer is normally required to control and run a management information system associated with a database.

1.3 Computerising the information system

The introduction of a computer will require the clear and unambiguous statement of what information is needed, which was mentioned in 1.2. However, an attempt to obtain such a statement will often reveal other difficulties. In 1.2 mention was also made of data flows contributing to an overall management information system. In reality provision of management information is usually not as effective as it could be because of the structure of the organisation. An examination of the inter-relationship between parts of an organisation will reveal how

complex the situation is. For example, the way in which one section works can have a profound effect on other sections. The factory may negotiate a complicated system of bonus schemes and productivity payments for the workers there. This will have an impact on the costing section and on the wages section. In both cases the procedures they use to determine product costs and employees' wages will need to reflect this complexity.

Many systems in use in an organisation will have evolved over a number of years. As circumstances change the people who have to make them work will have made the necessary changes. In most cases the systems will have been set up and altered on the basis of making them work. Some functions may be split over several sections. Other sections may have attracted additional functions over the years. A good example of this is the computing function itself. As we shall see in Chapter 2, the business computer is only the latest in a long line of machines designed and used principally for accounting work. If these early machines were allocated to the finance department, then probably the computer is their responsibility, although it may be performing many non-financial tasks.

Because of these problems there is a great deal of controversy about how to introduce a computer into a business. One suggestion is that a complete overhaul of the functions of an organisation should take place so that the various functions being carried out, eg production, marketing, can be rationalised.

The principal objection to this approach is that it takes too long, so that by the time it is complete circumstances will have changed and the system which has been designed no longer fully meets the requirements of the organisation. It will also cause considerable upheaval.

The alternative method is to select particular procedures and computerise them in turn so that gradually all the systems are on the computer. With the growth of the number of microcomputers the tendency towards these 'stand-alone' systems, as they are called, has increased. It must be borne in mind, however, that if these stand-alone systems are written without any thought for the overall requirements of a company, or even of a department, it is unlikely that they can be fitted into a more ambitious scheme of computerisation. An organisation wishing to proceed with computerisation will then be forced to write many of these systems again. This waste of resources can be largely avoided if some kind of overall plan is laid down initially so that the designer of each system is made aware that all systems must conform to certain standards. In particular he or she should pay attention to the data flows, which were discussed in 1.2.

The problem of defining where in an organisation a function begins and ends has to be decided before a system can be computerised. This will normally be laid down before the task is given to a systems analyst. In this way the analyst knows which parts of a system to look at, and which sections or departments are involved in the investigation. When

the use of a computer comes to be considered, the first stage must be to carry out a feasibility study. This should set out to identify the likely areas for computerisation and suggest cost-effective solutions. If this is done conscientiously it may be found that a computer is not a viable answer after all. Maybe an examination of the flow of work through the office will reveal how savings can be made in other ways; or a change in working practices may achieve the desired result. It is much better to find out at this stage rather than later on when the system has been computerised.

Such a study will normally be carried out by an experienced analyst who has a wide knowledge of business practice, methods of working and available equipment. It will be on his or her recommendation that the possibility of using a computer will be examined in more detail.

It is always tempting to suppose that from all the available computing equipment there must be something suitable for any application. This is usually true but it is always necessary to ask the fundamental question 'Why are we going to use a computer?'. For the successful implementation of a computerised system the user must be very clear about the problem areas with which he or she thinks the computer can help and the solution to the problem which the computer is to tackle. It is a mistake to think that computers in themselves are problem-solvers. They are not! The method of solving the problem must be supplied by people, then the computer can assist by performing the necessary calculations.

Another important question to ask is 'Shall we have our own computer or hire time from a bureau?'. Again it is tempting to think that computers are so cheap to buy that having one's own must be an advantage. This may not always be the case. The advantages and disadvantages of using a bureau are discussed in 8.6.

Summary

The organisation as it exists will have grown up and been extended over the years so that it no longer truly represents the functions the organisation carries out. Rationalising these functions may considerably delay computerisation. Existing functions can be computerised one by one as isolated systems, but care must be taken that each can later be fitted into the overall plan which contributes to the management information system. A feasibility study to determine whether a computer is an economic proposition is essential before resources are committed to computerisation.

1.4 Turning data into information

In the previous section we saw that many sources of information are used to enable organisations to make sensible decisions about their

business. Problems arise because the information needed is seldom to be found exactly in the form required. If we go to a supermarket and select a basketful of goods, the price of each item will have been marked on it. The operator at the checkout point, however, needs to know the total amount to charge us. This is the information required. The labels on the purchases tell us the individual amounts, but not until they have been added up can the information be obtained. This activity is an example of data processing. At this stage it may be as well to attempt to distinguish between 'data' and 'information', although the two words are often interchanged as if they meant the same thing. The prices on the goods purchased are in fact items of data. Processing the data by adding it up produces information ie the amount we have to pay. So in this instance the selling price of the item is data. Clearly someone will have had to work out what the selling price should be. Many factors will have been considered in setting the price, such as the cost of raw materials, the cost of manufacturing, and the price of packaging and distribution. In this case these are the items of data which are processed to make a piece of information – the selling price. As this example shows, the selling price is both data and information. Which it is depends on whether it is being processed to produce further information, or whether it is the result of some processing.

In an organisation each section or department will be processing data to provide information needed for it to carry out its work. Some of this information will be passed on to other sections. To them it is data to be used for processing so that they can produce information to do their jobs.

A typical business will perform large amounts of data processing of varying kinds. Much will be relatively simple, consisting of straightforward additions and subtractions. Some will be extremely complex, and will use complicated mathematical formulae. Whatever form the processing takes, two other activities are likely to take place. One is the collection of the data needed for a particular purpose and its transmission to a central point eg a computer centre. This is known as data capture. Then the data has to be put in a form which the computer can use. This is known as data preparation. These topics are considered in more detail in Chapter 5. Next comes the cycle which is common to all data-processing activities – input the data, process it according to some set rules and procedures, and output information.

For example, keeping shelves full of stock and making things in a factory are very different activities. Yet in both we can see the common pattern, which remains the same whether the work is done by clerks, by machines or by a computer. Before processing can begin some data must be made available either about stock levels or orders to be made for customers. This will form the input. Processing this input will take place according to some procedures laid down to tell the clerks what to do, or to schedule the machines in a particular sequence of operations. If a computer is involved these procedures will be incorporated in the

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