THIS IS IT

A Manager's Guide to Information Technology

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Preface

Information Technology (IT) is a new label for a collection of old ingredients, technologies which up to now have enjoyed disparate natures and histories. The ingredients have familiar labels: computers, telecommunications, electronics, office products and a host of other more specific items. The reasons for their separate natures have up to now been rooted not only in fundamental differences in technology but also in major external pressures, notably regulatory legislation.

In recent years major shifts have occurred in both of these separating influences, resulting in significant changes in the nature and structure of these industries. The major shift in the technological base has come with the extraordinary developments in microelectronics. The 'microchip' has rapidly become the basic component of a group of industries which previously relied on specialised components to preserve their separate identities.

Whilst the advent of microelectronics may have appeared to be a dramatic and overnight process, in fact the microchip has been quietly evolving over the past twenty years in a very predictable manner. In 1965 Dr Gordon Moore, then President of Fairchild Semiconductors, predicted that the density at which microelectronic circuits could be fabricated would roughly double every year into the foreseeable future (twice as many circuits that is would occupy the same physical space).

Since then this has in practice been the case and indeed is likely to continue into the future with very little slackening of pace. The amount of detail contained in the newest integrated circuits is almost beyond human comprehension. By way of an analogy, imagine a street map for the whole of the Greater London area reduced in size so that four complete maps would be no larger than a postage stamp.

The other major shift has been in the government's attitude to regulation. Three particular events characterise this change. In the UK the British Telecommunications Act (July 1981) which split British Telecom off from the Post Office also significantly liberalised their monopoly position. This Act, primarily influenced by the Beesley Report, has had a catalytic effect on British Telecom.

In January 1982 two major anti-trust cases were resolved in the USA. First, AT&T (the parent of the dominant American telephone system supplier, Bell Telephone) negotiated a settlement with the government which allows it to change from being a telephone company into one offering a range of telecommunications products and services (some of which have a distinctly data processing flavour to them). In return it has had to split up its operating companies into independent concerns.

Second, the US Justice Department dropped its long running (13 years) anti-trust suit against IBM, signalling the end of an era in attempting to contain the mighty giant of the computing world. With its interests in Satellite Business Systems and other telecommunications networks, IBM stands poised to extend its position of dominance in computing over even wider fields.

So what is Information Technology? The Department of Industry defines IT as: 'the acquisition, processing, storage and dissemination of vocal, pictorial, textual and numeric information by a microelectronics-based combination of computing and telecommunications'.

Other attempts at definition have been equally unwieldy. The French use the word *telematique* which somehow seems to capture the flavour of the subject better, while in the USA, Harvard's Antony Oettiger constructed the ghastly term 'compunications'. So it seems that IT is something which is better described than defined, and that is what we are attempting to do here.

The motivation to write this book grew out of a need to provide

teaching material for our courses at the London Business School. While there are plenty of good texts on specific aspects of computing, telecommunications, management information systems and so on, most of these are aimed at the systems design or data processing professional. Books that aim to cover this subject for students of management either provide too superficial consideration of the technology or else have rather a narrow perspective in their coverage.

We believe that it is important for managers to have a sound conceptual understanding of the components of Information Technology. For too long managers have been at the mercy of their technical experts, particularly in the data processing world. While this has been in large measure their own fault, it also stems from the attitude of the British educational system which esteems the value of arts and pure science over that of applied science. This may not have mattered so much while the application of Information Technology, in the guise of computers, was relatively limited. However, today the impact of IT on all aspects of business and social life is becoming inescapable, and in many instances is becoming the dominant technological influence on our personal and business lives. No longer can we afford to leave our fate in the hands of technical experts, since if we do they will in effect be taking major social, economic and political decisions about our future as individuals, the future of the organisations which employ us, and in some respects the future of Britain as we know it.

One of the major problems in writing a book such as this, is the rate at which the technology is developing. It is difficult enough to keep abreast of the developments in computing, let alone telecommunications, broadcasting, satellites, image processing, etc. Thus in this book we have tried to describe the basic concepts and principles behind each component of IT, since it is unlikely that these will change significantly over the course of the next decade. What does occur daily is the announcement of new products and processes. However, the lead time between a new line of technology becoming feasible and its widespread application is at least two years. Thus we would not expect to see any major omissions from our catalogue of technologies for the next couple of years.

What change even more rapidly than technology are the issues that relate to it. In the UK 1982 has been Information Technology

Year, and since we finished writing this book, there has been a major debate within the government on two specific issues. First, the Electronics Economic Development Committee (EDC) of the National Economic Development Office (NEDO) has published a blueprint for the electronics industry called *Policy for the Electronics Industry* (NEDO, Electronics EDC, 1982), which provides an excellent review of the industry and of the threats and opportunities facing it; but it is much less convincing in its policy proposals, which appear very much the same medicine as before.

Second, major proposals have been made to recable the country (see *Cable Systems*, A Report by the Information Technology Advisory Panel, Cabinet Office, 1982), in order to provide the necessary infrastructure for the information age (well, at least that part of it dependent upon the availability of 30 or more TV channels in every home). This could be done in a variety of ways ranging from the proposal for a chain of local cable TV companies covering perhaps half the population at a cost of £2.5 billion, to British Telecom's proposal to handle the whole project at a rather more leisurely pace.

Given our belief that a proper understanding of the significant elements and characteristics of the technology is a necessary prerequisite to a full awareness and appreciation of the application of Information Technology and of the major issues that it raises, we make no apology for devoting a significant part of this book to providing you with such an understanding.

The book is organised into six parts, each of which deals with a different aspect of Information Technology.

> In Part I we examine the historical context of information processing and attempt to categorise its different aspects.
>
> In Part II we lay out the fundamental concepts of computing from the basic operation of the hardware to the nature and problems of software. We conclude this section by discussing different approaches to file processing.
>
> Microelectronics is the theme of Part III where we look at the way the microchip has developed, the economics of production and consider in some detail current and future applications.

In Part IV we look at telecommunications and the development of different types of network made possible by adopting digital techniques. We examine the converging paths of telecommunications, computing and office products.

Office automation, one of the most hotly discussed facets of IT, is the topic of Part V. We investigate what makes up an office, consider technical solutions being promoted by the suppliers and examine how suited these are to users' real needs.

The first five parts deal with specific technical and management aspects of IT. Part VI deals with the wider social and national implications. Specificially, we discuss the debate on privacy and data protection, and the changing nature of work with its implications for the balance of skills, education and training. We conclude by examining the role of government in stimulating economic activity and its responsibility for aggregate employment, and the place of Information Technology as an agent of technical change in the national economy.

We have also produced a comprehensive Glossary of the particular terms and jargon which abound in this industry, as in every other.

In writing this book we have appreciated the encouragement and criticism of our colleagues, students and friends. In particular, we would like to acknowledge the special contributions of John Steffens for his many suggestions; of Marie Wright for decoding our handwriting and processing the words; of Philip Allan for his confidence in us; and, above all, of Milli and Sheila for their patience and support.

John Eaton and Jeremy Smithers
London Business School, July 1982

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Part I

INFORMATION SYSTEMS

Information Technology (IT) has developed in response to a demand for information processing. In many ways this requirement is a relatively recent phenomenon, brought about by the industrialisation of society. A far older, much more basic, requirement is the process of exchanging information. In the following pages we look at the exchange process and examine the effects of automation. We see how this gives us a natural progression into an information processing requirement.

1

The Process of Information Exchange

Information Exchange

In looking at information exchange, it is possible to identify three quite different forms of this process.

First, there is *individual communication*, in which information is exchanged on a one-to-one (or one-to-few) basis. This was the earliest and most basic form of communication and, unlike the other forms, it can be most effectively carried out without the use of any technology at all. Technology becomes necessary only when this communication takes place over any kind of distance. While technology enables this process to be carried out on a wider basis, it in no sense enhances the process. Personal communication is best done face-to-face and all the current technologies seem poor substitutes for this direct contact.

Second, there is *broadcasting* of information, which can be represented as a one-to-many process. There is a vast spectrum of information that may be broadcast that includes facts, opinions, propaganda etc. These exchanges may either be initiated by the transmitter or by the receiver. In the 'transmitter-driven' mode, an individual (or homogeneous group) wishes to transfer some information to a number of individuals (heterogeneous group). The receivers may be self-selecting or the audience may be specifically targeted. The type of information communicated may range from religious or political doctrine to commercial advertising. In the 'receiver-driven' mode, the

receiving group will be selecting or demanding the information from a particular source. Examples of this would be any sort of status reporting or forecasting (e.g. weather forecasts, road traffic reports).

Education falls into both these modes. At one end of the spectrum, authorities decide on the benefits of education and prescribe its dissemination; at the other end, individuals wish to learn a particular subject and acquire the necessary information. This 'one-to-many' process is possible without any technology — for example, at a public meeting — but it is fundamentally a process that has been vastly amplified by the use of technology.

The third form of information exchange is that of *accounting* (with a small 'a'). This word has gathered a quite specific connotation in connection with one commercial aspect of this process, but we use it here in the sense of the exchange of information, in order to keep a record of some activity.

Consider for a moment how we as individuals gain knowledge about a particular event. There are several possibilities: we might experience the event directly or indirectly (say on TV), and we may make some judgment about what occurred in both qualitative and quantitative terms; or we might have the event interpreted by an observer or commentator. In these ways we can gain good qualitative information, though it will tend to be very subjective. However, we are liable to have very meagre quantitative information. For example, if you go to a big football match, you know whether it is very crowded or not; but unless you know the capacity of the ground, it would be very difficult accurately to estimate the number of people watching. The commentator would have a much better idea because of previous experience and knowledge of the capacity of the ground, but we would not expect an estimate to be any more accurate than, say, to the nearest 10%. However, the management do need to know exactly the number of customers present, and so they must measure this accurately.

As Lord Kelvin once remarked, without measurement our knowledge of a particular subject is very meagre. Measurement provides some objective information about events that allows us to make comparisons and classifications. So if we are to find out objective information about some activity, process or event, then we must have records. (This is not to say that the records will necessarily be accurate or unbiased.) The initial gathering of

information involves observation, measurement and recording. Once these measurements are recorded, then the information must be classified and structured in some fashion. This is a critical stage as the organising process is bound to introduce subjective elements. To organise the information, it is necessary to have some model or view of how it is to be used and the real-world phenomena to which it relates. However, in execution of this process, original data are liable to be irreversibly transformed.

This third form of information exchange, accounting with a small 'a', has been greatly affected by technology. The process of measuring, recording, classifying and structuring information has been totally transformed by the application of IT.

To summarise, we consider that there are three quite different forms of information exchange, namely:

1. Personal communication (one-to-one)
2. Broadcast communication (one-to-many)
3. Accounting (event/activity to records)

Each of these forms of information exchange uses different types of media and technology. We will be identifying the automation trends in each of these forms and demonstrating that the three streams are being brought together into one interrelated whole.

Information Exchange — The Automation Trend

Personal Communication

Obviously the fundamental and most effective way of communicating is by face-to-face conversation. With the introduction of the telephone, it became possible to speak with another person as far distant as the other side of the world. Though the quality of the sound may not be particularly good, it is usually quite adequate to recognise the caller. The device is very simple to use (or in computer parlance it has a 'simple user-interface'), yet behind this simple instrument lies probably the most complex system yet built by mankind. (The telecommunications system is described in some detail later in the book.) It is now possible automatically to connect oneself to any one of over 700 million people. Yet communication via the telephone represents but a tiny fraction of total personal communication.

Later on in this book we will be discussing how the telephone is becoming the gateway into myriad services, which fall into the other categories of information exchange and handling. Slowly the distinction between categories is becoming eroded. For example, using Prestel (British Telecom's public viewdata service, discussed in Chapter 10), it is possible to leave a message for collection by someone else. Thus we have a system set up for broadcast and information retrieval purposes being used for personal communication.

Speculation about the future of the telephone suggests that it may well become a personal device travelling with us, rather than being fixed in a building. This is feasible with current technology. A recent study by PACTEL (part of the PA Consulting Group) predicts that mobile radio telephones will become very widely available within the next ten years. They may well become standard features of new motor cars before that. Indeed, looking further into the future, two NASA scientists estimated that it would be possible to build communication satellites several kilometres in diameter which would be powerful enough for individuals to communicate with it using a wrist transmitter, Captain Kirk style. Unfortunately the microwaves might also burn a hole in your arm!

Getting back down to earth again, it should be borne in mind that the telephone is a relatively recent invention. The first real communications technology was writing. Using simple materials, it was possible for an individual to communicate messages over long distances, albeit very slowly. This was perfectly satisfactory for many purposes and reflected the general pace of life.

For the major part of the time that written messages have existed, they were delivered individually or personally. When the volume reached a certain level, the distribution system started to be automated by the introduction of collection, sorting and delivery systems. Again, the user-interface is very simple — it is sufficient to know the address, fix the correct stamp and put the letter into an appropriate collection box. Behind this simple exterior a complex infrastructure has developed, although this was until recently based on relatively low technology and a lot of people. The only significant piece of technology to affect this process, from an individual's point of view, has been the typewriter. This did nothing to increase the volume of information

being transmitted, as most people type slower than they can write, but it did help the clarity of the text.

A more recent innovation has been the ability to send textual information over the telephone network, either as telex or telegrams. It is interesting to note that in doing this, the user-interface has become considerably more complicated, so that we need a specially trained operator as an intermediary. This cannot be an economic proposition in the long term, and it would therefore be reasonable to expect these systems to become simpler to use and more accessible.

People communicate on an individual basis, not only for personal and social reasons, but also for business reasons and it is here that major changes are likely. This is only possible because business information exchanges, in general, have quite specific objectives — to order some stock, or to check the availability of some item. People seem prepared to adopt new forms of communication if it will enhance the process of meeting these objectives; and a side effect of this will be to reduce the social interaction that takes place as a part of individual business communication.

The effect of technology, then, is to improve the 'quantity' of personal communication. It is now possible to send messages or converse over longer distances, quicker and cheaper than ever before. The earliest technologies were of vastly inferior quality to person-to-person communications, but gradually this quality is improving (*viz*, videophones and teleconferring). However, we do not believe that it will ever be as good quality as direct personal communications.

Broadcast Communication

The earliest way of broadcasting information was by voice, with a speaker or performer and an audience. There are many examples of this today: a sermon in church, a theatrical play, a political meeting. However, the great limitation of this process is the limited number of people one's message can reach at any one time. If the information has only a small potential audience, and they are located in one place, then there is no problem; but many items of information are designed for, or required by, far wider audiences.

Neither was handwriting an effective way of broadcasting information. Texts had to be laboriously copied and so were

similarly limited in the audience they could reach. The great breakthrough came when Gutenberg invented the printing press. This was the first time that it had been possible to automate any part of the dissemination of information process. The history of this development is well known, but it is still fascinating to reflect on how rapidly new ideas and beliefs swept through Europe in just a few years after its invention.

Today the printing process is reaching its maturity and will undoubtedly start to decline in the next century. Probably its major drawback, apart from depleting the world of timber, is its basic inability to discriminate. The economies of printing are tied very much to volume production and, as we move towards a more pluralistic world, the demand for uniform products is going to decrease. Printing will have to adjust itself to the philosophy of small batch production and to do that it will need to adopt the technologies that threaten to replace it entirely. Nevertheless, printed information today represents the major part of information that is broadcast.

There has been one recent major development in printing technology which has suited the changing requirements perfectly, namely that of reprographics or photocopying. This allows small numbers of copies of any document to be made without skilled help, rapidly and at a modest cost. In many ways the photocopier tolled the death knell of the privacy of information. Any document within an organisation could be easily copied without anyone being aware that this had been done. The effects of this have been very marked in terms of organisational democracy, as it is now virtually impossible to restrict information within an organisation, and often outside it too. However, the future of reprographics is totally dependent on there being printed (or written) documents in the first place. If, for example, printing as a means of recording information is totally superseded by some electronic form of storage, then photocopying would rapidly follow it into obscurity.

The spoken word, which had been eclipsed by the printed broadsheet, made an outstanding comeback with the arrival of radio. Here was an even more efficient way of disseminating information. While the capital cost of building the radio stations was high, the information could be received by a potentially infinite audience at no extra cost to the broadcaster (the investment in a receiver being borne by the listener). Indeed the word