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Trends in Information Technology

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The Butler Cox Foundation

THE BUTLER COX FOUNDATION

REPORT SERIES NO. 39

TRENDS IN INFORMATION TECHNOLOGY

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Abstract

Our generation has witnessed two great changes in the world of information technology. The first is a change of scope. From their limited beginnings 30 years ago in the commercial world, computers today are seen as all-pervasive, and rapidly becoming a central driving force in developed societies. The second great change is the dramatic improvement in the ratio of cost to performance. In no other field has advancing technology so sharply or consistently altered the price balance in favour of the customer.

The purpose of this report is to look ahead over the five-year period 1984 to 1988, identifying the major trends in information technology and drawing out some of the management implications of the changes. In particular the report raises the question how the role of the computer manager will change in the next five years. For some, the job of computer manager will become more technically complex. Others will extend their influence over the user environment: they will not directly control what users do, but they will control the context in which it is done. They will emerge more powerful from the rapidly changing world of the late 1980s.

Research team

The report was written by *David Butler*, Chairman of Butler Cox & Partners and of its research group the Butler Cox Foundation. Members of the research team were:

John Daly: a consultant with Butler Cox specialising in telecommunications and network design.

Neil Farmer: a consultant with Butler Cox specialising in office automation studies and multifunction office products.

David Flint: a consultant with Butler Cox with particular expertise in commercial systems, telecommunications and local network facilities.

Rob Moreton: a consultant with Butler Cox specialising in systems developments methods and data processing management.

Other Butler Cox staff involved in the research were:

Nick Souter, a consultant with Butler Cox with expertise in microcomputers and telecommunications; and *Pascale Boulanger,* a consultant with Butler Cox specialising in market research studies.

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THE BUTLER COX FOUNDATION

Butler Cox & Partners
Butler Cox is an independent management consultancy and research organisation, specialising in the application of information technology within commerce, government and industry. The company offers a wide range of services both to suppliers and users of this technology. The Butler Cox Foundation is a service operated by Butler Cox on behalf of subscribing members.

Objectives of The Foundation
The Butler Cox Foundation sets out to study on behalf of subscribing members the opportunities and possible threats arising from developments in the field of information systems.

The Foundation not only provides access to an extensive and coherent programme of continuous research, it also provides an opportunity for widespread exchange of experience and views between its members.

Membership of The Foundation
The majority of organisations participating in the Butler Cox Foundation are large organisations seeking to exploit to the full the most recent developments in information systems technology. An important minority of the membership is formed by suppliers of the technology. The membership is international with participants from Belgium, Denmark, France, Italy, the Netherlands, Sweden, Switzerland, the United Kingdom and elsewhere.

The Foundation research programme
The research programme is planned jointly by Butler Cox and by the member organisations. Half of the research topics are selected by Butler Cox and half by preferences expressed by the membership. Each year a short list of topics is circulated for consideration by the members. Member organisations rank the topics according to their own requirements and as a result of this process, members' preferences are determined.

Before each research project starts there is a further opportunity for members to influence the direction of the research. A detailed description of the project defining its scope and the issues to be addressed is sent to all members for comment.

The report series
The Foundation publishes six reports each year. The reports are intended to be read primarily by senior and middle managers who are concerned with the planning of information systems. They are, however, written in a style that makes them suitable to be read both by line managers and functional managers. The reports concentrate on defining key management issues and on offering advice and guidance on how and when to address those issues.

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THE BUTLER COX FOUNDATION

REPORT SERIES NO. 39

TRENDS IN INFORMATION TECHNOLOGY

CONTENTS

TRENDS IN INFORMATION TECHNOLOGY

REPORT SYNOPSIS

"Not seeing the wood for the trees" is an occupational hazard for managers concerned with information processing. The trees of technology are growing so fast and new branches are sprouting so luxuriantly that it really is difficult to discern the overall pattern. If the manager is not content to see the present pattern but wishes to know what to expect in the future, another dimension of difficulty is added.

Looking back is one way of starting to look forward. Over the past 20 years we have seen two great changes in information technology: a change from the esoteric to the all-pervasive, and an unprecedented steady improvement in the cost per unit of performance. Will these twin trends continue? This projection exercise looks at the next five years.

Technology advances stemming from research and development lead to new products and systems, from which the user has to make a choice. In the case of the information technology industry the user is faced also with a changing pattern of suppliers, as companies come, go and change their strategies. These external uncertainties are compounded by internal changes within the organisation, associated with changes in methods of working which are themselves the outcome of the new technologies. Based on all these factors, managements must set their course for the future.

The process begins with the technology, and here we examine (Chapter 2) trends in processors, workstations, printers, storage, and communication systems. In processors, the semi-conductor industry will continue to double the number of components per chip each year until the end of this decade. New silicon techniques and architectures will be followed by developments in optoelectronics using gallium arsenide.

In workstations, keyboards will survive, and higher-resolution split screens and specialised voice-recognition systems will be developed. In printer technology, we expect new software products which will make matrix printers into high-quality tools through electronic control and multiple passes.

In storage, our research suggests that magnetic storage will continue to offer price-performance gains for as far ahead as we can see. Advances will come from the use of thin-film heads, thin-film recording surfaces and vertical recording technology. Optical stores are farther away.

Communications topics of special interest to users of information systems include optical fibres, local area networks and cellular radio. One trend is the emergence of systems which combine the best points of both local area networks and PABXs. Cellular radio will be used initially for telephones in cars but cellular data services will follow.

Turning from technology to products, systems and services (Chapter 3), the trend in large computers will be towards dual processors and multiprocessors, for reasons of reliability. The key development in software will be the trend towards system building tools, which are becoming essential to the user as hardware costs fall, while the much-publicised expert systems will *not* revolutionise data processing in the five-year period. In systems, our view is that the future of information technology lies with the *distribution* of computer power and of data.

The distribution of information throughout organisations will depend on communications, and in the coming years PABXs will tend to become distributed. But true office automation traffic with text and image will overstrain the bandwidth of third-generation switches. Multifunction workstations will offer improved price-performance. Magnetic discs will remain the major form of backing storage until 1990 or longer, and content-addressable information stores will become necessary as office automation becomes more widespread. Within five years dot-matrix printers with graphics will be widely used; over ten years, full-colour ink-jet printers will become the norm.

Value-added network services will grow, and telex will continue to decline. Integrated services digital networks will be introduced gradually. Videoconferencing remains unlikely to take off in Europe during the 1980s. The trend towards smaller and cheaper point-of-sale terminals will continue. Limited-vocabulary, speaker-independent voice recognition systems will be available by 1987. In factory automation, flexible manufacturing systems will benefit even the smallest units.

Against this background, how will suppliers react? One general trend (Chapter 4) will be the move away from component products and towards system solutions, as computer suppliers respond to the pressures of a more sophisticated market and increased competition. Fewer different systems will be offered, but they will be flexible. Companies themselves will collaborate more. In office systems, it is not clear whether computer companies or communications companies will dominate. Network operators are moving towards greater added-value offerings in specialist markets.

IBM has changed, in the words of one commentator, from a battleship in mothballs to a fleet of killer submarines. Its overall strength, already astounding, is set to grow further following its aggressive entry into personal computing and its financial stakes in Intel and Rolm. IBM will use Rolm switching technology to power its assault on the office of the future. The biggest obstacle to IBM's success will be the other giant, AT&T. As for Japan, we believe that Japanese efforts to seize control of the world information technology market will be impeded by internal weaknesses, particularly in software.

So much for the external factors. As the systems within user organisations develop and change to reflect the external trends, how will the responsibilities for the management of these systems be modified? This we discuss in Chapter 5. One key trend, as mentioned, will be the growth of distributed systems: users, in consequence, will wish to design many of their own systems. This heralds a decline in the system-design role of the data processing department, which leaves the data processing manager with two distinct possible future roles.

One possible role is that of provider of technical services. The other is that of director of information, aiming to ensure that managers have access to the best possible information on which to plan and take decisions. IBM's concept of the Information Centre fits into the former option. Other new roles will emerge, and existing roles will be upgraded, for other staff.

End-user computing will grow in importance — and in difficulty. Its methods of system development will change rapidly and fundamentally.

Predicted technology advances of the next five years are listed in a "good news, bad news" summary in Chapter 6. On the basis of the developments which lie behind this list we put forward six guidelines for management:

—Watch for the key technology changes (such as Japan's progress, and steps towards Open Systems Interconnection).

—Maintain the long-term work aimed at improved software tools.

—Monitor the likely effects of trends on the information systems budget.

—Extend the role of the Information Centre (or whatever the support service is called) to embrace more, and more senior, end users.

—Identify key suppliers and monitor their prospects for survival.

—Consider the two possible new roles for the data processing manager — director of technical services, director of information — and whether they can be combined.

PREFACE

This report was researched and written in response to requests from Foundation members. Its purpose is to identify the major trends in information technology over the five-year period 1984 to 1988, and to draw out some of the management implications of these changes.

In particular the report discusses how the role of the computer manager will change in the next five years. As technology advances, the job of the computer manager will become more technically complex. As the value of information is more clearly perceived, the computer manager will be seen as a provider of information to management at every level. Is there a conflict here? If so, how can it be resolved?

Research methodology

The research for this report included a wide scrutiny of the available technical and product literature. It also involved over 40 interviews, of which the majority were with suppliers but some were with advanced users, conducted in the United States, Europe and Japan. Our findings in Japan shed light, though not yet a conclusive light, on the plausibility of Japan's Fifth Generation Computer Plan.

Readership and scope

Readers of this report should include managers responsible for information technology policies. Wherever possible, the report is written in language sufficiently non-technical to be intelligible to interested managers outside the systems function.

The report does not claim to cover all aspects of the world of information systems, nor to have selected the best products. Failure to mention a specific product should not be taken as any adverse judgement upon it. Individual products are mentioned merely as examples.

CHAPTER 1

THE GROWING IMPACT OF INFORMATION TECHNOLOGY

Our generation has witnessed two great changes in the world of information technology. The first is a change of scope. Twenty years ago computers were regarded, rightly or wrongly, as being limited in their scope to internal control functions within large enterprises and to the solution of large-scale problems in science and engineering. Financial directors and astronauts used computers. Today electronic technology is seen as all-pervasive. It is embodied in every kind of business, domestic and academic activity, and is rapidly becoming the driving force of developed societies. The second change is manifest in the dramatic and progressive improvement in the ratio of cost to performance. In no other field has advancing technology so sharply or so consistently altered the price balance in favour of the customer.

Will these trends continue? Will computer systems become ever cheaper, ever more powerful, ever more dominant in shaping economic activity and daily life?

In this report we try to assess how fast the trends will develop, and how far they will reach. If the world survives, a reader in the year 2000 may skim through our forecasts with tolerant amusement. If so, we suspect it will be our caution rather than our daring that amuses him.

The year 1979 has been described as the year in which the "computer-room walls came tumbling down", the year in which the personal computer and all its associated applications turned systems into an open house. It is difficult, even impossible, to measure in money terms the extent of the change in systems usage. Small computers find their way into companies not only as part of the authorised data processing expenditure but also on users' budgets, sometimes not even identified as computers. The American consultant Philip Dorn (Reference 1) estimated in 1982 that, for each dollar spent by the computer department, roughly 35 cents was spent on computing by users.

INFORMATION TECHNOLOGY AND ECONOMIC TRENDS

Economic trends favour both the continued expansion of the information technology industry and an attack on new problems. The World Bank has forecast that by the year 2000 the population of the world will have increased from today's 4.4 billion to 6.1 billion. Over 80 per cent of the expected population growth will occur in less-developed countries, characterised by severe shortages of resources such as food, energy and water. Information technology will be harnessed not only to the management of enterprises in developed economies but also to the conservation and exploitation of scarce resources in the Third World.

Within the developed countries, experts have detected rapid and significant changes in employment patterns. In 1960 clerical workers in America numbered ten million, or 15 per cent of the total workforce. By 1980 their ranks had swollen to 18 million, 19 per cent of the total. How permanent is this increase in the population of office workers? IBM (Reference 2) quotes the increase in typing productivity through word processors as 148 per cent. Thus the spread of information technology creates conflicting trends, increasing jobs in one area and reducing them in another. In France, for instance, the total number of people employed in information technology by 1985 will rise to 230,000, but the numbers engaged in data collection will decline from 35 per cent to 22 per cent of the total.

ACCEPTED TRENDS IN INFORMATION TECHNOLOGY

Within the information technology industry, there is a concensus that certain industrial trends will continue and will grow in importance. These trends, which represent the accepted wisdom of today, are examined in later chapters of this report. They may be summarised as follows:

1. The cost-performance ratio of equipment will continue to improve.
2. Personal computers will proliferate.
3. The improvement and expansion of communications facilities will permit working from home.

4. There will be a large growth in available software tools, to match the growth in the population of users.
5. The level of skills of the general population in the use of computers will rise.

If these trends develop there are two consequences of huge significance, not only for the information technology industry but also for its customers. Traditionally the industry has been driven by technology. Research and development has generated new hardware, which has been released not when the market demanded it but when the vendor chose to release it. In an increasingly fragmented and consumer-driven market, how will the information technology industry perform? Will companies respond to demand in the personal computer market while simultaneously trying to control the large systems market? Or will consumer orientation spread through the entire market?

Throughout its existence the Butler Cox Foundation has tracked the convergence of technologies, the process by which the skills and target markets of the computer, communications and office systems industries have tended to overlap and merge. If the proliferation of home computing, networks and work-at-home actually takes place, we shall witness a new and even more startling convergence. The means of delivering data, text, voice and graphic signals via cable, satellite or radio to workers at home will also be used to deliver sports, news and films for their leisure hours. The new convergence will thus embrace the information technology industry and the world of entertainment, news and broadcasting. New companies may spring up to exploit this opportunity. Certainly every company that sells products or services to the consumer will need to develop a totally new sales and marketing philosophy.

The new mass markets for information technology will not be easily or cheaply built, as experience with videotex has shown. Two key criteria for general acceptability are terminal design and the provision of facilities. Physically the terminals of the 1990s will be compact and well-suited to their environment. New levels of flexibility in use will also have to be attained. If not, the expansion in personal computing, communications and working at home will be slowed down.

CHAPTER 2

TRENDS IN TECHNOLOGY

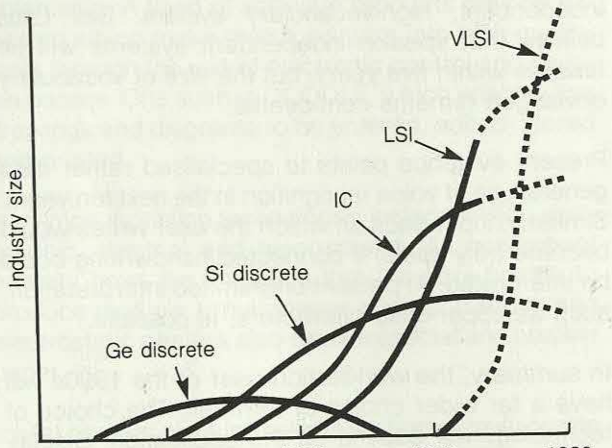
In this chapter we examine the trends in five fundamental areas of technology, namely processors, workstations, printers, storage and communication systems.

PROCESSING TECHNOLOGY

The semiconductor industry will continue to double the number of components per chip each year until the end of this decade. Storage circuits conform more closely to this basic rule of technological progress than do logic circuits, because of their regular structure and standardised functions. Because microprocessors and communication circuits have a substantial stored-program element, they also conform well in price and performance to basic technological trends.

Figure 2.1 shows how semiconductor technology has followed a surprisingly regular seven-year cycle of development since the invention of the transistor. Among the wide and somewhat confusing range of innovations now being pursued by the semiconductor makers, two trends appear to be particularly

Figure 2.1 Cycles of development in semiconductor technology



(Source: Institution of Electrical Engineers 1983)

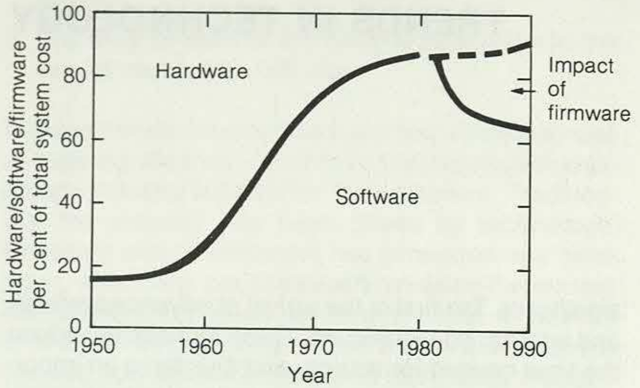
significant. The first is the arrival of advanced refresh and addressing techniques. These techniques reduce the time needed for testing, and thus have an important impact on the cost, for example, of new dynamic random-access memories (DRAMs) now available in 256k bit form.

The second major trend involves chip architecture. DRAMs, traditionally 1-bit-wide devices, are now becoming common in 16k byte, 4-bit-wide architectures. During 1984 we expect to see the release of a 32k byte, 8-bit-wide static random access memory (SRAM). Access time will be 150 nanoseconds. 256k bit complementary metal-oxide-semiconductor technology will also be released in 1984.

There are many examples of advancing technology, of which we cite only a few. In 1984 again, 64k bit erasable programmable memories (EPROMs) will be in production, with typical erase/write times of 10 milliseconds and with control logic on a chip. DRAMs will continue to dominate the market for arrays over one megabyte. For smaller arrays SRAMs are smaller and easier to use, and consume less power. As software proliferates, read-only memories (ROMs) and electrically erasable devices (EEPROMs) will become more important in program storage. The level of integration pursued by manufacturers will not depend on technology alone. They will wish to retain flexibility in product assembly, and this is most easily achieved with application-specific assembly modules.

In the more distant future the quest for smaller size, greater speed, lower power, reduced heat output, higher reliability and easier design and testing will lead the industry towards new technologies and new materials. Optoelectronics, using gallium arsenide, is likely to be one such technology. It uses light as the transmission medium and electricity as the switching power and it will compete with (but not replace) today's MOS/bipolar silicon. In non-linear optics light is used both to transmit and to switch, but we do not expect this technology to be significant within the next decade. Josephson technology also may remain insignificant for the next decade: IBM's recent withdrawal of interest in superconductive circuitry is a pointer, though Fujitsu still lists it as an area of research activity.

Figure 2.2 The effect of firmware on total software cost



(Source: Infotech State of the Art report, Business Information Systems, 1981)

In addition to changes in basic technology, suppliers of microprocessors will increasingly adopt microcode or firmware. The systems of the next decade will incorporate firmware for timesharing and multi-programming, file and list management, high-order level command execution, fault protection and detection, and fast computation sequences.

Figure 2.2 shows the estimated impact of firmware on the make-up of total system costs by 1990.

WORKSTATION TECHNOLOGY

Our research with advanced suppliers confirms that, despite the usefulness of touch-sensitive screens and the mouse (a screen-controlling device that works by rolling across a flat surface under hand operation), keyboards are expected to survive for many years. The current generation of management is overcoming its initial dislike of the keyboard. The next generation is using keyboards at school or college (over $25 million of computers were shipped to schools in Britain alone during 1983). Moreover, the keyboards of today are capable of considerable enhancement. Soft keys are becoming more widely used as application generators. They provide a more acceptable alternative to the conventional inquiry-response iteration commonly employed in database searches.

Throughout the remainder of the 1980s, the trend towards higher-resolution screens will continue. (One American supplier's new screen, becoming available in 1984, has a matrix of 720 x 340 points, and replaces an earlier design having 432 x 319 points.) Functions will be provided concurrently, so that the user can compile a text report using the word processor, call up a graph or spreadsheet and include it in the text, as if assembling a report with paper and scissors.

Split screens will remain in use throughout the 1980s. IBM's new 3270 PC, for example, can be attached to host computers to display information simultaneously in seven windows. Combined with concurrent processing, such display facilities are of obvious power.

Flat screens also are products of the future. At present a flat display is approximately four times as costly as a cathode ray tube. But this price disadvantage is widely expected to decline. By 1993 flat screens may have stolen half the market for display screens. Three basic display technologies, liquid crystal, plasma and electroluminescent, will compete for the market.

Alternating-current plasma display panels offer several advantages compared with cathode ray tubes in both industrial and military applications. Total absence of flicker and complete freedom from geometric distortion means that operators who look at screens for prolonged periods are less fatigued. Latest developments offer multi-pixel graphic capability — and because the memory is inherent, the display remains unfaded so that repeated refresh (needed for cathode ray tubes) is not required. Selective writing and erasure of the displayed image is much easier than with cathode ray tubes, and there is absolutely no risk of implosion. In addition, the flat panel leads to improved ergonomic design.

Voice-recognition attachments to workstations are available now, but they can recognise only a limited vocabulary of discrete words, rather than continuous speech. Japanese research is heavily concentrated on voice-recognition, so that future developments may well be very exciting.

In October 1983 NEC demonstrated a continuous-speech voice-recognition system with a vocabulary of 500 words. Pricing of chip sets begins at $100. NEC believes it is ten or 20 years from a speaker-independent, high-vocabulary system. Bell Labs believe that speaker-independent systems will be feasible within five years, but the size of vocabulary envisaged remains confidential.

Present evidence points to specialised rather than general use of voice recognition in the next ten years. Similarly, input pads on which the user writes would become truly useful if connected handwriting could be interpreted. At present only limited interpretation, such as upper-case characters, is possible.

In summary, the workstation user of the 1990s will have a far wider choice of terminal. The choice of technology will depend on the application. Display technology is a case in point. For expensive, high-grade colour displays such as picture videotex, bit-mapped display techniques will be used. For portable terminals, liquid crystal will find favour. For more mundane data processing purposes, alternating-current plasma display panels will be used, gradually displacing CRTs from 1985 onwards. Direct-current plasma technology is a laboratory concept, perhaps a longshot to overrun all other technologies.

PRINTER TECHNOLOGY

The traditional line printer, using revolving drum or chain or reciprocating train technology, is still responsible for much of the output from information systems. The only recent innovation of significance in this area is the Tally comb, which has 132 teeth. Each tooth has a steel ball at its tip. The characters are formed from a matrix of dots, with seven lines of dots forming a row of characters. The dots are printed by the impact of the balls striking the print ribbon on to the paper. The comb mechanism is simple and reliable.

The earliest impact printer was the IBM Selectric golfball. Until 1972, when Diablo Systems invented the daisy wheel, the Selectric was the only letter-quality printer available. The daisy wheel was recognised as more reliable, less noisy and faster than the golfball (55 characters per second as against 15).

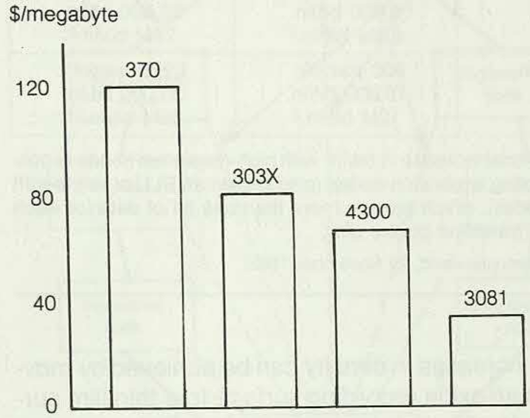
Matrix printers, like the golfball and the daisy wheel, are single-character printers. But, unlike the others, the matrix printer forms each character from a dot matrix. Early matrix printing has been enhanced by the use of electronic control and the addition of a second print-head. Print speeds of 400 to 500 characters per second are now attainable. Further developments have included the use of a single line of needles rather than a matrix, giving a cheaper approach. The 'infinite matrix' principle also has been invented, whereby the print-head makes successive passes and distributes its imprint so as to make a more perfect letter image. Letter-quality printing is obtainable. A flood of software products may be expected which make matrix printers into high-quality tools through the use of electronic control and multiple passes. One such is DOODLE, which enables line drawings and diagrams to be entered, edited, stored and printed.

Non-impact printing technologies include ink-jet, xerographic, thermal and electrostatic. All non-impact printers have the limitation that they are unable to produce multiple simultaneous copies. Thermal and electrostatic printers also require special and costlier paper.

Ink-jet printers eject ink selectively from a multi-nozzle print-head. They are quiet and they produce high-quality print. Xerographic printers use the same technology as office copiers. They can run at up to 20,000 lines per minute, and can overlay form headings as they print. Thermal printers exploit the reaction of special paper to heat, as selected matrix probes heat the paper's surface. They are small, light, reliable and cheap. Electrostatic printers apply a voltage to a stationary linear array of conducting ribs. An electrostatic image is created on sensitive paper and developed with liquid toner. The printer is fast and silent, its quality can be very high, and font flexibility also is good. Electrostatic printers have no moving parts, other than for paper handling.

Figure 2.3 The declining unit cost of disc storage

Figures based on average disc costs per CPU family. Disc costs are based on original list prices. Controller costs not included.



(Source: Computerworld, 29 November 1982)

STORAGE TECHNOLOGY

Recent years have seen rapid improvements in the cost-performance of magnetic storage devices. Figure 2.3 shows, by way of illustration, the cost per megabyte of disc storage over four ranges of IBM computer.

Will conventional magnetic storage media offer further price-performance gains in the future? If not, then new media such as optical discs may become more attractive. Our research, however, suggests that magnetic storage will continue to offer price-performance gains for as far ahead as we can see. Three main technological advances point in this direction.

The first is the substitution of thin-film heads for ferrite heads. Thin-film heads are manufactured, like semiconductors, by deposition and photolithography. They are much more sensitive than mechanically produced ferrite heads. Used with an oxide recording surface, thin-film heads can give a recording density 50 per cent greater than that obtained with ferrite heads.

Figure 2.4 Increase in storage density attainable with thin-film heads and disc surfaces

Head type	*Conventional disc*	*Thin-film disc*
Conventional	960 track/in. 6,600 bit/in. 6.3M bit/in.^{2}	1,200 track/in. 20,000 bit/in. 24M bit/in.^{2}
Thin film	800 track/in. 15,000 bit/in. 12M bit/in.^{2}	1,200 track/in. 30,000 bit/in. 36M bit/in.^{2*}

*An additional increase in bit/in. with high-resolution heads is possible by using expansion codes (also known as RLL or run length limited codes), which provide more than one bit of data for each magnetic transition on the disc.

(Source: Computerworld, 29 November 1982)

Further increases in density can be achieved by moving from an oxide recording surface to a thin-film surface made of cobalt or a cobalt alloy. The recording density of 6,500 bits/inch (2,560 bits/cm) on oxide compares with 20,000 bits/inch (7,870 bits/cm) on thin film, using ferrite heads. Different approaches are being tried. The IBM 3380 offers thin-film heads with a conventional surface. Others favour thin-film surface with ferrite heads. Figure 2.4 shows the impact upon attainable density, in terms of bits per inch on the track and tracks per inch on the surface, of thin-film heads and discs.

The third way in which technological advances are leading to price-performance gains in magnetic storage is through the promise of recording densities far in excess even of the 30,000 bits/inch (11,800 bits/cm) achievable with thin-film heads and surfaces. This promise is created by vertical recording technology. Conventionally, the magnetic domains that represent bits on a disc surface are horizontal, like bar magnets lying on a table. The polarity of the field indicates its binary status. The density of storage with horizontal domains is limited because the poles of the domains can be misread if they are too closely packed. Vertical recording stands the domains on end. Each domain's polarity, north or south, can then be more easily detected by the read-head, even when the domains are more densely packed. Even in its infancy, vertical recording on a cobalt/chrome surface offers densities of 100,000 bits/inch (39,300 bits/cm). The highest density achieved in laboratories to date is 440,000 bits/inch.

A 100-megabyte store on conventional Winchester disc requires an eight-inch surface. In 1983 Vertimag stated that it expected soon to offer the same capacity on a 5-inch surface, using vertical storage. We see magnetic storage surviving well into the 1990s. Despite the announcement in 1983 by Matsushita of "the world's first erasable optical disc", we believe it will be several years before magnetic media begin to yield market share to optical stores.

COMMUNICATIONS TECHNOLOGY

Three aspects of communication technology are of special interest and promise to users of information systems. They are optical fibres, local area networks and cellular radio.

Optical fibre technology

Optical fibre may be used both for wide-area and local-area links. At most cable lengths (except very short links) fibre has advantages, and as development continues these advantages will increase. The cost benefits of fibres were recently analysed in Communications Engineering International (Reference 3). For normal duplex asynchronous applications, screened twisted-pair copper cable is usually adequate for links up to 100 metres. Attenuation of signals is a problem only if the limits of the bandwidth are pressed hard. At this distance the extra cost of optoelectronic converters is not justified.

Links of 100-500 metres, the commonest for computers, cover the economic cross-over point. Low-bandwidth links of this length may continue to use screened twisted-pair, but the signal-to-noise ratio becomes a problem. Line drivers can solve the problem but at a cost of, say, $600 apiece. In this case the cable solution costs $1,470, while the fibre solution costs $1,220.

For wide-area links, fibre is becoming even more attractive. Transmission at 140M bit/s over 100 kilometres without a repeater was demonstrated in 1982. With high-powered lasers and the best detection equipment, links of over 300 kilometres without repeaters are envisaged for the future. Many PTTs now have fibre-optic wide-area links in service. By the end of 1984 NTT (Nippon Telegraph & Telephone Public Corporation) in Japan will have in operation a 2,800 kilometre optical fibre trunk network.

Local area networks

Both within the Butler Cox Foundation and in wider circles, a spirited debate has continued over Local Area Networks (LANs) and Private Automatic Branch Exchanges (PABXs). PABX systems consist of a traditional star network, however disguised. Wires fan out from the centre, as illustrated in Figure 2.5. LANs, on the other hand, provide a single high-speed communication path that can link together a variety of different office devices (see Figure 2.6).

Do LANs and PABXs compete or complement? It seems that a concensus is now emerging, which says that communication systems can exploit the best points of each. Product offerings are now emerging which illustrate this trend. Figure 2.7 illustrates how

Figure 2.5 Conventional PABX configuration

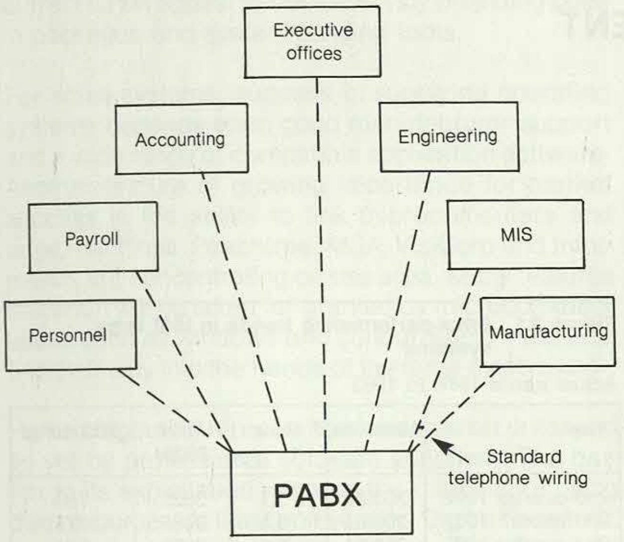
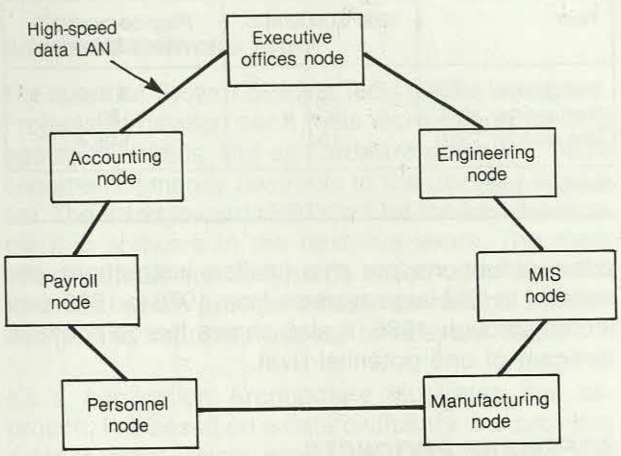


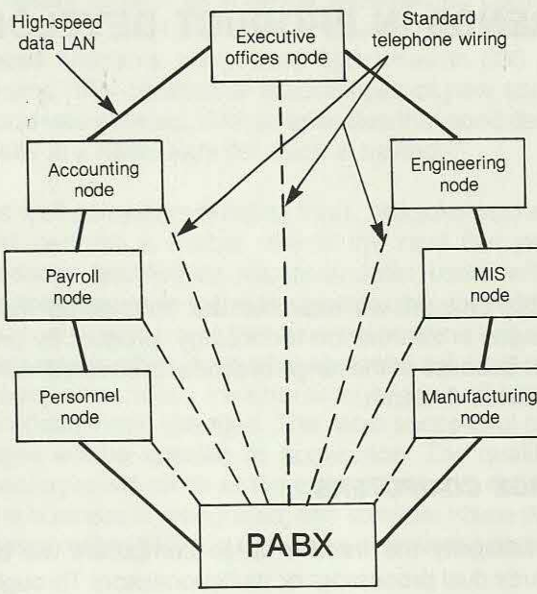
Figure 2.6 Typical LAN configuration



a conventional PABX star network can be combined with a high-speed data network. New PABX products emerging in America use LAN techniques to communicate between nodes, employing token ring (or Ethernet) technology. IBM will probably announce their long-awaited LAN product during 1984, and this is certain to have a major impact on the marketplace.

Ethernet CSMA/CD (Carrier Sense Multiple Access/Collision Detect) technology is more suitable for short distances with up to about 100 terminals. With longer

Figure 2.7 Combined PABX and LAN networks



cable lengths there is a greater possibility that two attached terminals may transmit virtually simultaneously. Such data collisions, without tokens, require a retransmission. Token passing is more cumbersome and sometimes causes longer delays, but the delays are predictable and hence manageable.

Cellular radio

Finally let us turn to cellular radio. This technology seeks to liberate mobile users of radio from the capacity limitations of the radio spectrum. An area, perhaps a city, is subdivided into geographic cells, and each cell is served by a low-powered base station with its own set of frequencies. Adjoining cells use different frequencies to avoid interference. Remote cells may re-use the same frequencies. Cells are linked by computer-controlled switches, and mobile users can be linked with each other or with the public networks. When a mobile user crosses from one cell to the next, he is switched to a new frequency automatically. If bandwidth runs out, the cells can be further subdivided.

The initial use of cellular systems will be for telephones in cars but, as modems and other devices become available, cellular data services also will become available — probably before 1990.

CHAPTER 3

TRENDS IN PRODUCT DEVELOPMENT

In this chapter we examine the anticipated main changes in information technology, product by product. Because of the range of products covered, none is treated in depth.

LARGE COMPUTERS

For reliability the trend in large computers will be towards dual processors or multiprocessors. Throughout the 1980s, cost performance will improve by around 17 per cent per annum, about 15 per cent being handed to the customer in price reductions. The systems implemented will become more modular, and error detection and correction logic will become standard. Operating systems will be partitioned and applications programs built into the system.

The longer-term future of the large computer is a matter of contention. Some experts see large systems disappearing within ten years. Others, for instance the American forecasting firm Predicasts, see the large system market growing at over four per cent per annum for the next 12 years. Competitive technical design issues will abound. Until 1990, debate about cooling systems will continue. IBM favours water cooling because chips are easier to make if heat dissipation is externally managed. Others such as Fujitsu try to solve the heat problem at source. Amdahl uses fast chips with slow connectors. IBM uses slow chips with fast connectors and expects to win the race for fast chips and flow connectors by 1985. As a distinct alternative, the start-up company Trilogy will develop the 'wafer scale' technology. Instead of building very thin wafers with circuits implanted in each chip, an unsliced sausage is made. This sausage (2-3 inches) replaces hundreds of individual chips wired to circuit boards. Trilogy claims lower cost and better reliability for this approach, with mean time between faults of four years.

IBM and other big firms will continue to take minority positions in key supplier companies. IBM holds 13.7 per cent of Intel stock, and uses Intel chips for its PC personal computer.

The results of these technical and competitive manoeuvres benefit the customer. Figure 3.1 shows the price reductions per mip (million instructions per second) in IBM large systems from 1978 to 1983, projected through 1986. It also shows the competitive forecast of one potential rival.

Figure 3.1 Price-performance trends in IBM large systems

Actual trends 1978 to 1983

Year	*Machine*	*Mips*	*Price $000s*	*$000s/mip*
2nd quarter 1978	3033U	5.1	3825	750
2nd quarter 1979	3033U	5.1	3685	723
2nd quarter 1980	3033U	5.1	3075	603
2nd quarter 1981	3033U	5.1	2570	504
2nd quarter 1982	3081D	10.2	4005	393
2nd quarter 1983	3081K	13.7	4640	339

Extrapolated trends to 1986

Year	*IBM $000s/mip*	*Plug-compatible rival $000s/mip*
2nd quarter 1984	281	201
2nd quarter 1985	234	180
2nd quarter 1986	194	149

(Source: Trilogy)

SOFTWARE PRODUCTS

In the early 1960s when hardware was costly, software accounted for only about 20 per cent of the cost of a system. Today the position has reversed: it is hardware that accounts for the minor part of total expenditure and software the major.

Operating systems

User interfaces designed to make systems more 'user-friendly' are important with small systems, less so with large ones. The market for operating systems for small systems is a promising one for vendors. In the United States alone in 1983 it reached $350m, and is forecast to grow to $2.2bn by 1987. The most visible competing products today are MSDOS, CP/M-86 (and Concurrent CP/M), Unix, Pick and UCSD p-systems. Of these Unix is likely to remain a tool for skilled practitioners, though commanding a useful product market. Many Unix features will migrate to other operating systems. Pick and Concurrent CP/M appeal to customers by providing built-in packages and system-building tools.

For small systems, success in supplying operating systems depends upon good manufacturer support and a wide range of compatible application software. Another feature of growing importance for market success is the ability to link microcomputers and large machines. Peachtree, MSA, VisiCorp and Informatics are concentrating on this area. Many features that soon will be taken for granted by microcomputer users, such as windows and concurrency, must also find their way into the hands of the large system user.

Home computing represents a vast market untapped as yet by professional software suppliers. The barrier to its exploitation remains the difficulty of using disc resources. At least one vendor, Digital Research, is now addressing the home market with a library of routines (VIP) front-ended to application packages to present a common interface irrespective of job or operating system.

Advanced software tools

The quest for System Building Tools (SBTs) is not new. Projects to develop such tools were begun as long ago as the 1960s. But as hardware costs fall, SBTs become not merely desirable to the user but essential. The trend towards SBTs will be the key development in software in the next five years. The most effective tools are likely to be based upon data dictionaries, which provide a basis for rational system design and improved access to relevant data.

ICL's Application Architecture illustrates this approach. It is based on a data dictionary and provides a set of linked skeletal programs which end users can flesh out with a fourth-generation language. ICL's Application Architecture is claimed to cut development times by 90 per cent. Nevertheless most SBTs will, in a period of three to five years, continue to be used by professional systems staff. The Information Centre concept will help to promote the use of SBTs by end users, though the process will be gradual.

The stimulus of research into software engineering in Europe, the United States and Japan will gradually change software from a craft to a professional discipline. In the attempt to reduce the volume of new code which must be written for any particular application, prototyping, generators of programs and systems and re-usable code modules will all play a part. Prototypes already provide a practical link between user, analyst and designer, and will increasingly lead to adequate, rudimentary working systems.

Reusable code is an old but under-exploited idea. At a Butler Cox conference in the Netherlands (Reference 4) the software house CAP described how on a recent project its analysts identified 60 common functions. The 4,500 lines of source code covering these functions were used 500 times in 200 programs. The creation of 50,000 lines of new source code was avoided. CAP emphasises that good design skills are necessary for such a saving.

As well as system building tools, bespoke packages will perform a crucial role in the next five years. Lessons learned by microcomputer users will be passed upstream to the big-system user, the most important lesson being that a partial solution to a problem now is often preferable to a total solution in two years' time, when the character of the problem will probably have changed. The most successful packages will be specific to application. The quality of packages will climb as the capital-intensive nature of the business is recognised: one software house (MSA) has invested $65m in five years in financial systems.

Expert systems

Foundation Report No. 37 — Expert systems — discussed the future of expert systems. It envisaged two levels of implementation, namely full-scale systems in a specialised field costing over $1m and smaller, prototype systems costing some $30,000. The report proposed five guidelines for user organisations: users should move into expert systems only when:

- Knowledge is already available in written form.
- The application area calls for continuous update of logic rules.
- A system can be developed in a modular way.
- The user has an incentive to use the system.
- The user can maintain and improve the knowledge base.

Expert systems, we concluded, would not revolutionise data processing in the next five years.

DISTRIBUTED SYSTEMS

On one point all computer suppliers are in accord: that the future of information technology lies with the distribution of computer power and of data. This trend does not necessarily herald the demise of the central computer. IBM estimates that for every mip installed locally two mips will be required at the centre. If this proves to be correct then high estimates for the sale of desk-top devices, as in Figure 3.2, would suggest that mainframe sales also will remain healthy.

By 1990 the cost of the processor and memory in a desk-top microcomputer will be less than the cost of

Figure 3.2 Projected sales of desk-top microcomputers under $12,000 (1982 to 1990)

	Year	Business 000s	Home 000s	Total 000s
France	1982 to 1985	494	359	854
	1985 to 1990	1,860	1,193	3,053
Italy	1982 to 1985	303	205	509
	1985 to 1990	1,244	642	1,886
United Kingdom	1982 to 1985	882	1,394	2,277
	1985 to 1990	2,255	948	3,204

(Source: Pactel)

the keyboard and power supply. Large-scale memory in desk-top microcomputers (100M bytes) will also be commonplace.

What will be the main demands among users of distributed systems? The first will be improved control over system development, in order to facilitate the long-delayed task of basic system conversion. The second will be the need to increase responsibility for system operation, to offset the risks inherent in remote data processing.

In a genuine distributed system users are unaware of and indifferent to the physical location of data. The route to this ideal situation is still far from clear. Successful implementations of such networks are few in number and sometimes too specialised in purpose to provide general guidance. Bell's Common Channel Interface Signalling (CCIS) network is a case in point, a packet-switched network of real transparency which serves the restricted purpose of handling signals on a telephone network.

Data integrity versus cost remains the central problem. Available solutions such as record lock-up, date and time stamping and concurrent update are cumbersome and costly. For the time being software products designed to limit the inconvenience of central storage, mitigating the problem of downloading, represent the least bad available solution.

The distribution of intelligence through organisations will depend upon communications, as well as on desk-top and mainframe computers. PABX configurations (as depicted in Figure 2.5) have traditionally been star-shaped, even when the PABX is digital. In the coming years the trend will be for PABXs to become distributed. Switching nodes will be located on several floors of a building, in scattered buildings or in remote locations. Each node will handle its own telephone extensions and (on remote sites) exchange lines. Nodes will be linked to the main controlling processor by high-speed digital circuits, usually 2M bit/s.

Wiring, moves and changes of areas all become much simpler. Several suppliers, including Philips, ITT, CXC and Ztel are moving toward distributed PABX functions.

As data traffic grows in the late 1980s and early 1990s the benefits of digital PABXs and time-division multiplexing will become more obvious. Data plugs will be used to transmit simultaneous voice and data. But real office automation traffic, with text and image added, will overstrain the bandwidth of third-generation switches. The fourth generation of PABXs will come into use in the United States in 1984. It will feature:

- —Distributed switching, control and databases.
- —Non-blocking capability for voice and data.
- —Integral LAN available to all nodes.
- —Digital at the handset.
- —Protocol conversion.
- —High-level language for network control.
- —Absence of a single controlling processor.

WORKSTATION, STORAGE AND HARD-COPY DEVICES

Reduced prices and increased function will mark the workstations of the next five years. Devices with one megabyte of store and 40M bytes of backing store will be available by 1985 at prices between $5,000 and $15,000. The price of workstations will be further reduced when a large fixed disc is shared between them through the use of a local area network. Novel input media will progress, but not displace the keyboard.

Workstations

The market for workstations — as the example of Apple's Lisa shows — is very price-sensitive. Buyers are interested in more power for less money rather than in novelty for its own sake. Display facilities are a key attraction, provided the price is right. By 1986 a multifunction terminal with raster-scan facsimile will be on sale at the price of today's facsimile transceiver — around $5,000.

The storage overhead of image versus text, today about 10:1, is gradually being eroded by compression techniques. As image compression techniques advance, a promising future for Optical Character Recognition (OCR) appears to beckon. But suppliers remain unexcited, arguing that in most organisations about two-thirds of documents are created internally and can be captured at source. In the United States voice message capabilities are highly valued as a feature of workstations. It remains to be seen whether these features will be equally popular in Europe, without the North American time-zone differences.

Storage

Magnetic discs will remain the major form of backing storage at least until 1990. Developments such as thin-film coating (as opposed to oxide) and thin-film monolithic heads will sustain continued cost-performance improvements. Videodisc at present is a candidate only for archival storage, because its update capability is limited. The recently announced Philips Megadoc system offers a 12-inch disc with one gigabyte per side and 125-millisecond access time.

Under development now are read-only optical devices like a compact music disc applied to data. In the long term read/write optical discs will appear, though the date is uncertain. The latest experiments with vertical magnetic recording techniques suggest that, by 1985, the 5-inch Winchester drive will offer 500 megabytes of storage.

Content-addressable information stores will become necessary as office automation becomes more widespread. We expect traditional systems such as IBM's Stairs and ICI's Assasin, to be further developed to meet this need. The interface with users will be improved and very large text bases (one to five gigabytes) will be accommodated.

Hard-copy devices

Two different sets of criteria, working in opposite directions, influence users' choice of hard-copy printers. On the one hand is the simple combination of cost and print quality, tending to dominate short-term choice and sustaining existing technology. On the other hand, the proliferation of advanced terminals with graphics, and the wish to transfer displayed images to paper, lead users towards printers that are silent, have colour graphics, and offer better quality printing and the use of plain paper.

Since the appearance of laser and ink-jet printers (1978 and 1979 respectively) the demise of impact printers has been confidently predicted. But conventional technology, in the form of matrix printing with microprocessor control, has shown a surprising resilience. So far only ink-jet printers offer all that a user might wish. We do not anticipate full-colour laser printing before 1990. Our research indicates a phased market development. In the next five years dot-matrix printers with graphics will be widely used. Matrix and daisy-wheel printers will be partially replaced over ten years by office laser printers.

Also over ten years, full-colour ink-jet printers will gradually become the norm, as a result of spectacular price reductions. Thereafter, full-colour lasers will be popular. Laser printers with text capability are unlikely to fall below $9,000 in price, while ink-jet printers will eventually fall to $1,000 and dot-matrix printers will continue at around $5,000.

NETWORK SERVICES

The growth in data communications sprang originally from the advent of remote computer access and more recently from distributed processing. That development led to networking and, in turn, to the growth of network services.

Value-added network services (VANs)

A VAN service takes a third party's data traffic on a network and changes either its format or its means of delivery to the recipient. Examples of the former include protocol conversion or speed change. Examples of the latter are message store and forward, and electronic mail.

The evolution of the VAN service market may be illustrated by GTE Telenet. Its first offering linked low-speed asynchronous terminals to host computers. In the past two years Telenet has introduced a range of services for IBM devices, such as 3270 and 2780, to permit (for instance) 3270 users to access multiple hosts. Following the trend towards greater added value, GTE now offers (in conjunction with the American Medical Association) a specialised database and electronic mail service to the medical and health-care professions.

Text message services

Telex will progressively decline, victim of a limited character set, low speed and reliance on circuit switching. Telex's obvious rivals are the various forms of electronic mail on offer, though as yet no dominant product is visible. The teletex standard offers only a partial response to the need. Advocates of the standard object to its being called a telex update, but as yet it cannot deal with voice or video traffic. By 1990 old telex and some new teletex services will yield to fully integrated communication services.

Integrated services digital networks

In many countries Integrated Services Digital Networks (ISDNs) will be introduced gradually during the 1980s. In Britain, for example, the initial ISDN service, known as IDA, will be restricted to the three largest cities: London, Birmingham and Manchester.

Take-up will be gradual, as will be extension beyond these three cities. The costs of IDA will initially be high, since terminating equipment will be expensive. Costs will decline, but only when ISDN standards become available for equipment interfaces and for data interchange, will the true benefits begin to accrue.

An international ISDN specification to provide 144k bit/s access is expected in 1986 or 1987. Meanwhile, other digital services, such as point-to-point private digital lines, are already in use. Packet-switched networks will also expand rapidly in the late 1980s, providing database and host facilities to an infinite variety of terminal and microcomputer users. All networks, analogue and digital, packet-switched or circuit-switched, will become more secure. The installation of intelligent terminators allows the carrier remotely to test the line, the terminal device and the terminator itself. Eventually the carrier might arrange remote restart and recovery — but not before 1990.

Videoconferences

Despite its apparent effectiveness in reducing the cost and time of physical travel, the videoconference has never proved attractive. Even in North America, where distance adds relevance, its success has been limited. In Europe there is little evidence to suggest any major upturn in videoconferencing. Computer-controlled transmission, sending only the picture changes, reduces the required bandwidth to around 1.5M bit/s. Wide-area transmission costs can be substantially reduced. But there may be factors other than cost (the nuances, for instance, of human interactions) which inhibit the use of videoconferences.

Communication standards

Standards are needed to permit interconnection and intercommunication between products of different suppliers. At present the standards-making bodies of the world are very sanguine about their prospects. The International Standards Organisation (ISO) met in Ottawa in 1983 to consider the most recent drafts of standards for its seven-layer model aimed at open systems interconnection. An air of confidence, even of euphoria, seems to have prevailed.

There are good reasons to expect serious progress on standards. The US Government has been forcing military and civil standard-makers to co-operate, and using the huge defence budget to bully suppliers into compliance. Commercial pressure also exists: almost every American supplier is building gateways to IBM's SNA. Europe will wait with bated breath to see whether the giants will support or undermine the drive towards communications standards.

Cellular radio services

On page 7 we described the basic technology of cellular radio. We turn now to the kinds of product and service which will become available. In the American market AT&T has always been active, initially through Bell Labs and latterly through Advanced Mobile Phone Service (AMPS). AMPS provides a service in the 800-900 MHz range, with overall cell sizes which range from 40 km down to 5 km in diameter. A full-size AMPS system can support over 100,000 subscribers. Other suppliers, including ITT and Motorola, have developed AMPS-compatible services. Commercial operations began in early 1984.

In Europe, the Nordic Mobile Telephone (NMT) system is already operational. It is a co-operative venture of the Nordic PTTs. More than 30,000 customers were registered on NMT by the middle of 1983. Elsewhere in Europe, systems known as TACS (an AMPS derivative), MATS-E (Philips and CIT-Alcatel) and C-900 (Siemens) have been initiated.

Once a critical mass of voice customers is established, cellular radio operators will seek new applications. Possible tasks include order entry, telemetry and vehicle routeing and despatch. Another possible application is the control of field service operations.

OTHER PRODUCTS AND SERVICES

Other significant products and services include videotex, point-of-sale terminals and electronic funds transfer, and voice synthesis and recognition. In this section we also look briefly at advances in factory automation.

Videotex

Videotex systems, offering cheap terminals, easy communication and simple user protocols, are now well established. Through gateway facilities, organisations can make their databases available to third parties. In Germany the Bildschirmtext gateway has been available since 1980. A similar gateway is an inherent part of France's Teletel videotex service. Over 250 independent private videotex systems have been installed in Britain, some of which are accessible through the Prestel gateway.

Increasingly, videotex systems are being integrated into normal data processing as just one of a range of supportable communication standards. They are a cheap and user-friendly way to collect data, such as airline reservations or sales data from a travelling salesman. Increasingly, the communication link is packet-switched. But in the medium term we expect those implementations of videotex which offer tree-search database access to be superseded by more powerful search techniques.

As yet no dominant competitor to videotex's tree-search has emerged. In the longer term, associative retrieval methods will become established, using techniques developed from research into artificial intelligence.

Point-of-sale terminals and electronic funds transfer

In 1978 a typical point-of-sale (POS) terminal was electromechanical and cost $800. In 1983 a smaller, electronic terminal cost $250. This trend towards smaller and cheaper terminals will continue over the next five years. The established suppliers (such as IBM and ICL) will continue to market large systems, capable of linking all the cash registers in a shop. At smaller retail outlets, the cash register will be linked to a personal computer to handle sales and accounting information. Japanese suppliers will be very active in the down-market segment.

In the next five years POS terminals will be linked to the computers of clearing banks, or the credit-card companies, providing electronic funds transfer systems (EFTS). Test networks for EFTS will be installed in several European countries by 1985.

What the retailer requires is a single terminal to handle all common credit cards. The card-wipe operation will take six to eight seconds. The debit to the customer account may be instantaneous, or take a few days as with a personal cheque, or take some weeks as with a credit card. First-generation EFTS will use a separate black box to act as a 9600 bit/s line driver. The second-generation EFTS will see the integration of the terminal with the black box; second-generation devices will be available in parallel with those of the first generation. Third-generation systems will see the POS terminal linked directly to the network.

The benefits of EFTS are reduced paperwork for stores and reduced losses from fraud for the banks. In 1982, over 90 per cent of retail trade in Britain was in cash, but with credit-card trade growing at 30 to 40 per cent per annum EFTS is bound to be a growth business.

Voice synthesis and recognition

Our researcher in Tokyo was told that voice recognition of Japanese language would be "well established" by 1990. This is typical of statements made by suppliers, but the spread of complexity between simple and sophisticated systems is enormous.

We believe that commercial, speaker-independent voice recognition with a limited vocabulary of, say, 50 words will be available by 1987. Such a system would be suitable for what we consider to be the main application — voice control with limited functionality.

We do not consider that continuous-speech, speaker-independent, large-vocabulary voice recognition will become a commercial proposition in less than ten years. We believe also that the general market pressure for such a system is not strong. In certain specialised areas, though, the benefits of human language translation will be sought after. Fujitsu is working on a system which involves the user in a dialogue to clarify uncertainties. The system is expected to translate Japanese technical manuals into English by 1988. In a demonstration in Tokyo, however, translation of a ten-word sentence took four seconds of processor time on a large mainframe computer, and 24 seconds elapsed time!

Overall, we are convinced that voice interrogation of databases with voice response will prove feasible well before 1990. We do not expect voice-activated systems to become universal in this timescale, rather they will be restricted to a specific set of applications such as telephone access to databases or electronic mailbox.

Factory automation

Factory automation began in large production units such as motor-car plants. It can now be used in quite small organisations. A firm producing printed-circuit boards in batches of only 50 to 100 can employ automatic design facilities linked to robot assemblers. Within the next five years the claim that almost no plant is too small to use flexible manufacturing systems will become true.

Our researcher in Tokyo found a copier factory in which a single assembly line produced fifteen different models. The line can be run for 30 minutes to produce one model then switched to another under program control. The system also is linked to inventory management.

CHAPTER 4

THE STRATEGIES OF SUPPLIERS

In this chapter we consider how the strategies of suppliers will evolve. We do not attempt to describe each and every company involved in information technology, but the major trends are defined and relevant examples given.

One overriding theme which runs throughout is the trend from product to system. All suppliers, responding to the pressures of a more sophisticated market and increased competition, will tend to offer system solutions rather than the components of a do-it-yourself solution. Instead of selling a particular local area network to retailers, for instance, suppliers will sell a retail store management system with the network buried in it. "We are all systems houses now", said a manager from a certain telecommunications company. He never spoke a truer word.

COMPUTER SUPPLIERS

In this section we consider the strategies of computer suppliers. More detailed consideration is paid to IBM in a later section. Although suppliers are rarely willing to discuss future products and markets, all begin from the twin assumptions of faster technological evolution and increased competition. Among other common aims are improved quality of product as a route to higher profits, the provision of a wide range of distributed processing devices including network products, and the development of services to customers. Software tools and packages will be aimed at easy implementation.

In the next five years it is likely that the variety of different systems will reduce. At both ends of the market there will be fewer and more standardised systems on offer, but with compensatory flexibility. These systems will be more reliable and maintainable, as a result of investments now being made. At the lower end of the market, even large suppliers will turn increasingly to third-party distribution.

The need to stay close to state-of-the-art technology will strain the research and development budgets of even the largest firms. Collaborations will increase, along the lines of Sperry Univac and Digital Equipment Corporation (Digital) with Trilogy, ICL and Amdahl with Fujitsu. AT&T is collaborating with both Philips and Olivetti in Europe. Even IBM will secure collaborative positions in other companies, as it has with Intel, Rolm and Epson printers. There is a movement in the computer industry analogous to that in the car industry.

It is uncertain how many firms will continue to compete in the large computer business. IBM will do so. Some Japanese companies will do so. One or two plug-compatible suppliers will survive. Who else and for how long is far from clear. A senior IBM executive told our researcher that IBM aims to offer the best price/performance, allied with good support. He expects this policy to impose "severe strain" on traditional competitors, who increasingly will opt for joint ventures with Japan. The deals will ensure survival for three to five years, when Japan will begin direct marketing into Europe.

There is, however, a curiously self-limiting feature in the apparent erosion of competition. With some exceptions — and much heart-searching — computer suppliers are now widely inclined to accept as inevitable the multi-vendor site. The zeal for standards, de facto or de jure, creates the opportunity for interworking. Thus suppliers of office terminals target automatically on linking to IBM mainframes, Digital minicomputers and Wang word processors. Product differentiation in the future (for those who have a future) will depend more heavily on interworking software and on software packages. At the end of the decade, says Ulric Weil (Reference 5), users will be spending 80 per cent of their budget on software and only 20 per cent on hardware. As IBM impoverishes one generation of competitors it creates the opportunities for the next.

OFFICE SYSTEMS: ALTERNATIVE SCENARIOS

Because the office systems industry is less developed than the data processing industry, its likely evolution is less clear. Some computer companies believe they are well-placed to dominate the office systems industry, and surveys conducted by Butler Cox indicate that major users of such systems look to their computer suppliers to meet all but their communication needs.

Insofar as all office systems are communication-based, the communications industry may seem well-placed to provide them. But communications companies are traditionally weak in software. Other scenarios depict Europe as likely to be dominated by alien suppliers, initially perhaps Japanese but later Korean or Taiwanese. Such threats, already much in the minds of EEC officials, may lead to an upturn in European protectionist policies. Some scenarios view the future of office systems as belonging exclusively to giant corporations, others see this expanding market as a unique opportunity for the small to grow large. Only as a relatively few semi-standard configurations of hardware and software begin to be accepted will it be possible to assess the merit of each contending scenario.

NETWORK SERVICES

As already mentioned, network operators are moving beyond protocol and speed conversion to offer greater added value in specialist markets. In the United States the common carriers such as AT&T and GTE Telenet have been driven towards value-added services by the decreasing profitability of straightforward bit-transport services, a trend which we expect to develop also in Europe. Examples of these services include Telenet's medical service and AT&T's specialised network to locate spare parts and vehicles for the Ford Motor Company and its distributors. The latter system closely resembles the vehicle stock locator system developed by Istel (formerly BL Systems Limited) in Britain.

For similar reasons suppliers of local as well as wide area networks will also wish to add specialised functions to their offerings. Again they will be driven to specialise according to user group, but many will find themselves short of the background and skills to develop such user-oriented network products. Thus more partnerships are likely to spring up in both the LAN and VAN markets.

The development of markets for network services in the United States has been stimulated by deregulation. Federal Communication Commission rules now permit any owner of a private network to carry the traffic of a third party. No value need be added. Consider these rules in conjunction with the delivery of vast amounts of extra bandwidth in the form of digital circuits, fibres, radio links and satellites. Large organisations such as service bureaux with spare capacity can compete at marginal tariffs for third-party business.

Significantly, Telenet's network service to the medical and health-care community was developed as a joint venture with the American Medical Association. IBM is offering a network service to the insurance industry, and AT&T may offer a service to the transport industry. The degree to which deregulation will be used in Europe to stimulate competition in network services remains to be seen. In Britain the main national carrier, British Telecom, also sees basic bit transport as inadequate to support its revenue growth. It expects to offer value-added services in competition with other licensed operators.

The appeal of externally offered network services to users, who might otherwise develop their own private networks, rests upon six advantages. Users:

- —Need not select and purchase equipment.
- —Need not commit themselves to a long-term network design.
- —Can obtain service more quickly and change their requirements more easily.
- —Can buy network management as well as service.
- —Can avoid capital expenditure.
- —Need not hire skilled staff of their own.

IBM

Since its worldwide reorganisation began in 1981, and since the burden of the Justice Department's case was so dramatically lifted from its shoulders in January 1982, IBM has become both more aggressive and more outward-looking. IBM's ability to respond to competitive threats had in any case sharpened considerably. Poor demand forecasting, based on a faulty understanding of price/demand elasticity, led to long delivery delays of mid-range equipment in the late 1970s, so creating opportunities for the 'plug-compatible' manufacturers. Price cuts and new models in 1981 and 1982 dealt crushing blows to IBM's rivals. Storage Technology's profits fell by a quarter, Magnuson went to the wall. An American writer, Stephen McClellan, put it neatly (Reference 6): "In the 1970s IBM was a battleship in mothballs. Today it is a fleet of killer submarines."

The launch of the PC in August 1981 broke many accepted practices, with IBM for the first time buying components from outside and selling through retailers like Sears and ComputerLand as well as through its own sales force. IBM is believed to have spent $36m to launch the PC. By mid-1983 the PC had already taken 21 per cent of the $7.5bn US market for personal computers, overtaking Apple as the market leader.

The launch of the PC Junior in November 1983 at a retail price of $699 was another blow at the competition. It is a 64k machine comparable to the Apple IIe on sale at $1,500. The launch of the PC Junior was greeted with the usual jibes from the technical press. "It's a dud", said one of IBM's own suppliers. His frankness (or rashness) was explained by a later comment. "IBM's master plan is to take all the business back themselves. They let suckers like us establish the market for them, then they come in and take it over." But, dud or not, American retailers are reported to have "begged" IBM to let them sell the PC Junior. The advance publicity, a good built-in teaching program, and much-publicised shortages of supply — only 500 machines for the whole of Manhattan in January and February 1984 — will ensure PC Junior's success.

IBM's overall strength is astounding. Its sales in 1982 were five times those of Digital. It is market leader in nearly all the 130 countries where it trades. Even in Japan it shipped nearly as much product ($1.9bn) as the market leader Fujitsu ($2.1bn). As if its aggressive moves into the personal computing world were not enough, IBM has made other moves to strengthen its position. In 1982 IBM spent $250m to acquire 12 per cent of Intel. In June 1983 it paid $228m for a 15 per cent share of Rolm. IBM will use Rolm switching technology to power its assault on the office of the future.

All these moves have been accompanied by a near-doubling of IBM's share price. Not only is IBM, in its new aggressive mode, reshaping its own business; it also has a substantial impact on the information technology industry as a whole. The PC Junior is widely expected to sell half a million units in 1984 and a million in 1985.

Sales income of a billion dollars a year on PC Junior is good news for IBM. It will also make several other companies rich. For instance Microsoft, which sold MS/DOS to IBM for the PC, has not only earned $2m from sales to IBM but $10m from sales to other suppliers pursuing PC compatibility. Microsoft's sales rose from $32m to around $70m in one year. It expects to earn $10m from PC Junior in 1984. Other beneficiaries of IBM's new policies include Qume ($30m contract for discs), Advanced Input Devices ($15m contract for keyboards; 1982 sales totalled $4m), AMP Inc ($40m contract for connectors) and above all Teledyne, the company which assembles, tests and packages PC Junior. Teledyne will earn $40m in the first year.

Perhaps the biggest obstacle to IBM's attainment of its aims is AT&T. From January 1984 the battle of the giants is joined in earnest. The European Commission continues to pursue its anti-trust case, despite the US Justice Department's loss of zeal. No one can tell whether the Commission's lawyers will dent the armour of IBM's shrewd, determined and money-no-object legal defenders.

JAPAN INC

Butler Cox research for this report included interviews with ten major corporations in Japan and strategic analysis of 12 relevant technical reports.

Because of the close co-ordination of effort by the major Japanese companies, fostered by the industry ministry and the banks, the press has come to refer to Japan's thrust into information technology as if it were a single integrated program like that of IBM. This impression is misleading, though it is true that Japan has a more co-ordinated approach than any other nation. The Fifth Generation Computer Plan was launched in October 1981. It is planned to run for about a decade and to result in saleable products by the mid-1990s. The term 'Fifth Generation' has no literal meaning, it merely symbolises the degree of advancement inherent in the plans.

The Fifth Generation Plan is based upon the development of artificial intelligence and aims at the development of systems to handle imprecise concepts as well as numbers, words and images. Three years of preliminary work were carried out by government, industry and universities before the project was launched. The initial work was conducted by the Japan Information Processing Development Corporation (JIPDEC), but the project has now been transferred to a new organisation, the Institute for the New Generation Computer Technology (ICOT).

ICOT's aim is to achieve worldwide leadership for Japanese industry in information technology. The Japanese, however, are not averse to using other nations' expertise where their own is deficient. Soon after the project was launched, delegations from several countries were invited to Japan to receive details of the plan and to be invited to participate in the work, particularly in such areas of traditional Japanese weakness as software design. At best the reaction of the western delegations was guarded. The United States stopped short of an outright snub but sent a ludicrously underpowered delegation to the talks, the clearest possible indication of scepticism. Officials present at the talks speculated whether the foreign delegations were seriously meant to consider participation in the Fifth Generation Plan, or whether their presence in Tokyo was merely intended to impress Japanese Treasury officials and soften them up for the Fifth Generation Plan's huge budgetary requests.

So far the main result of these talks has been to stimulate activity both in national programmes competing with Japan and in international ventures like the ESPRIT project of the CEC (Commission of the European Communities). We understand, however, that official contacts continue. Meantime, American and European firms continue to pursue bilateral deals with Japanese companies which may have just as important results, even if they are not government-inspired.

The scope of the Fifth Generation Plan embraces both hardware and software. The VLSI programme is designed to establish revolutionary new technologies in semiconductor manufacture. Software and human interface problems to be tackled include the "inference engine" (a non-deterministic, non-linear approach to problem solving), the management of knowledge bases and the intelligent interface.

How seriously should this project be taken? It certainly cannot be left to suppliers and government officials alone to worry about the Fifth Generation Plan. If the project were to succeed, Western users would become strategically dependent on Japanese suppliers. The ruthless tactics adopted by Japan in world trade to date should have taught us a lesson. Suppose Japanese companies, using their traditional skills in high-volume, low-cost, high-quality production, were to secure by 1995 a position of dominance equivalent to that now enjoyed by IBM. What would be the results? Huge losses of jobs and multi-billion dollar trade deficits would be the first consequence.

The second consequence would be more insidious. Might not the banks, the paymasters of Japanese industry, act through the Japanese information technology companies to impose an unofficial, even covert strategic embargo on their European and American competitors? This action would condemn western banks to high costs and lack of competitive edge by controlling their advance in systems. Such risks may appear far-fetched, even insulting to Japan's business ethics. But we should remember that IBM, working in this instance with the Federal government and not against it, has already successfully prosecuted employees of two major Japanese companies for attempted theft of its secrets. A further civil case was admitted by a Japanese company.

The entire Japanese computer industry has under three per cent of the American data processing market, and IBM plans to keep it that way. This should not blind us to the fact that Japan takes a ruthless and exploitative view of world markets. If the Fifth Generation Plan takes Japan to a dominant position in Europe and the United States, Western users can expect to pay dearly. Nevertheless the credibility of Japan's intentions remains in dispute. "[The Japanese] are formidable rivals", said the manager of IBM's East Fishkill plant, "but we're ahead." Other industry spokesmen go further, viewing the Fifth Generation Plan as a smokescreen to hide problems Japan finds intractable.

Our own research suggests that Japanese efforts to seize control of the world market will be impeded by two internal weaknesses. In the first place, Japan's domestic market for information technology may be insufficiently developed — or insufficiently evenly developed — to sustain the growth of the industry. One or two companies such as Kao Soap and Tateshi Denki make widespread use of personal computers. But in Japan in general, personal computing is a rarity. In Tokyo the retail software business is highly developed, but outside the capital retailers are interested only in selling hardware. The concept of the Information Centre is difficult for the Japanese to grasp: how can data processing staff help users, when they have their own work to do?

The use of certain key technologies in Japan is still bound up in regulation and bureaucracy. In October 1983 JIPDEC arranged a satellite conference with the United States. But JIPDEC had to hire the circuit through a broadcasting company, which was obliged to include a pre-recorded programme in the transmission to justify the use of the circuit. Pressure from Japanese multinational corporations to ease satellite rules may prove effective by 1985, but the corporations are unlikely to be permitted to use their own groundstations. Cable TV services in Japan are a minefield of legislative and regulatory problems, ranging from the question of who is allowed to dig up the road, through the overlapping ownership of broadcasting and cable companies to the task of dismantling the NTT and KDD (Kokusai Denshin Denwa Company Limited) duopoly on third-party traffic. Our research suggests that, in the area of cable, Japan's much vaunted government/industry collaboration has not yet begun to work.

We found evidence to sustain the belief that Japan's traditional weakness in software, based upon incomprehension of its value and importance, continues. The total information technology market in Japan is growing at about 22 per cent per annum, but the market for large system software at only 15 per cent. Only five per cent of all software sales are of software products, the rest being bespoke. We learned that, in general, Japanese buyers are unwilling to pay more than ten per cent of the hardware price for any software product. Thus as hardware cheapens the software market becomes more constricted.

Japanese perceptions of markets may differ vastly from European or American views. Home facsimile is regarded as big business in Japan. NTT has installed over 10,000 domestic transceivers. They are used by residential customers to communicate with their office, their bank, their investment advisers and doctors or hospitals. It is claimed that all social classes employ this service. It is also claimed that videotex and cable systems pose no threat to home facsimile, because hard copy is a must. Despite many areas of common interest to Japan and the West, such as ISDN, LANs, fibre optics and factory automation, certain other areas of Japanese interest appear to

Western eyes exotic or even downright eccentric. They may lead Japanese companies to invest in developments which have little impact on world markets.

The second internal weakness which may undermine the Fifth Generation Plan is economic. Some expert Japan-watchers, Peter Drucker among them, now argue that the Japanese economic miracle is over. They expect Japan's economic decline to be as rapid and spectacular as its rise. Drucker points to a combination of factors leading to this decline (Reference 7). The traditional advantage of Japanese companies in capital formation may now be nearing its end, as the government piles up huge deficits. Japan, once the youngest of developed nations, now has the most rapidly ageing population in the world as birth-rates drop and life expectancy grows. Finally, says Drucker, the traditional labour policies of Japan — paternalistic and protective — cannot permit the shakeout and replacement of labour needed to remain healthy. Thus with its domestic market arguably headed for recession, the Japanese information technology industry may face an insuperable problem.

However we may assess the prospects of the Japanese plans, European governments clearly take the Fifth Generation Plan seriously enough to respond. In Britain the Alvey programme has been launched with target funding of £350m ($490m) to undertake joint research into VLSI, knowledge-based systems, software engineering and the human interface. At the level of the CEC, the ESPRIT project has been established with target funding of $450m in 1984-88. Initial projects with $20m have already been authorised.

CHAPTER 5
CHANGING RESPONSIBILITIES

Having described the main changes in technology for the years ahead, the product trends and the strategies open to suppliers, we turn now to the user organisation. How will responsibilities for the management of systems change? We first examine the role of traditional data processing, and then look in turn at end-user computing, the professional system builder, and finally computers, communications and office systems.

THE ROLE OF DATA PROCESSING

With the advance of distributed systems, users who have equipment on their own site will prefer to tackle the development of many of their own systems with their own staff. For this reason the data processing department's exclusive role in system design will diminish. Yet, even for users who design all or some of their own systems, the data processing department will still fulfil a useful role as a provider of shared services and of advice and guidance. Some staff who were formerly employed in data processing departments are already beginning to migrate to business units, a trend which will accelerate. End-user computing will expand into many areas of routine development, leaving the data processing department to concentrate on more complex applications.

At this point, according to arguments now being deployed, two distinct roles for the data processing manager become possible. Some data processing managers will be able to combine both roles. Others may have to choose, or run the risk of succeeding at neither.

The first role is defined as that of a provider of technical services. It embraces database structures, high-level system-building tools and communications networks and facilities. The analysts and programmers working in this area will be highly competent. They may, for instance, be experts in Open Systems Interconnection. They will also have a detailed knowledge of the public and private network services available at any given time, both local and wide-area.

The second potential role of the data processing manager will depend upon the growing recognition at the highest management levels that information is a key corporate resource, infinitely transportable and inexhaustible. This recognition has led some commentators to suggest that the data processing manager will develop into a director of information, with a brief to ensure that top management and business-unit managers have access to the best possible information on which to plan and take decisions. In this scenario it is of secondary importance whether the information is structured or not, whether it is internally generated or not. The director of information (it is argued) will serve the company in much the same way as an intelligence officer serves an army in war.

At present this potential bifurcation in the role of the data processing manager presents a serious career choice. The characteristics of the two roles may be very different, though as far as we know no psychological profile of them has been made. For a data processing manager now in his forties, what is the correct course of action? Should he strengthen the technical skills of his team, let routine system development migrate to the user, and strengthen his own understanding of the organisation's information needs? This is a high-prize, high-risk strategy, because the data processing manager's staff may become too technical to manage, his users may prefer not to share their understanding of information needs (a key qualification, after all, for their own survival) and he may end up neither a high-grade technical director nor an accepted director of knowledge. Moreover our research leads us to doubt whether the role of director of information is a permanent one.

During this transitional period, some senior managers may respond well to the opportunity to discuss what information they need to manage their part of the enterprise. Many will not. Many take the view that they already know what information they need, but just cannot get it. It is perfectly possible that, as more and more managers gain access to information through flexible and powerful systems, the role of the director of information would in any case simply wither away.

A less risky option, therefore, is to accept the technical challenge and leave the knowledge gap to be filled by someone else, perhaps a behavioural scientist. There is also a third option: to appoint a trusted technical manager to run the shared services, and to concentrate on securing the director of information's role, in the hope that if this fails retreat will still be possible.

The technical toolkits required to fulfil the new role are gradually becoming better understood. To support system development and maintenance, the data processing department will need high-order software aids such as database query languages and application generators. Such tools will be used initially by professional analysts and programmers but by 1990 will be widely employed by end users. Database design and redesign will be a central task for the data processing department, which will be constantly building structures that permit users to develop their own input-output programs. The systems analyst will tend to become more expert in data structure and data analysis, and less involved with the technical internals of the database.

Most of the necessary concepts for the technical support role — though not the director of information's role — are embodied in IBM's concept of the Information Centre. Users are provided with guidance on development, hardware and software selection, training and operational support. This approach appeals to data processing managers because it creates an arena for their skills. It also appeals to IBM because it creates a shop window for products and services. Nonetheless, it may also be of advantage to the user.

We can identify six new roles which we expect to emerge, or existing roles which will grow in significance. The first is that of the database administrator concerned with database hardware, software and performance. The second is that of the network engineer concerned with network structures and interworking of devices and systems. Third is the expert in configuration of systems, whose job is to resolve design problems in distributed systems. Fourth is the application software expert, specialising in the provision of high-level system-building tools. Fifth is the business application specialist, who understands the needs of a particular business area. Such specialists will not only understand the technical choices to be made but also the related business, industrial relations and human factors. Sixth and last is the technical consultant who guides the user towards appropriate techniques and software for each application, and provides training and education. Software evaluation is becoming more important than hardware evaluation.

Recognising the changing role of the information systems department, some companies have already set up their departments as independent commercial concerns offering services also to third parties. The wisdom of such a change is a matter for each organisation to determine, but we expect the information systems department in most cases to move to a more formal and arm's-length relationship. Its marketing role will become more apparent. Its need for proper strategic planning also will become more obvious, as expenditure on people, systems and tools increases. Expenditure on resources such as these is harder to justify and their exploitation is more difficult than for tangible items such as hardware.

The management task of the systems manager therefore becomes more difficult as the expenditure profile changes. Nevertheless, the process by which information systems become more diffuse in organisations will increasingly become self-fuelling. In Citibank, for example, a pilot study of electronic mail in 1982 used 200 terminals. By the end of 1984 Citibank expects to have installed 10,000 terminals among 60,000 employees, and these terminals have many other functions beside electronic mail.

In the new organisational era, senior data processing staff will be well qualified by knowledge and experience to survive and prosper. But the data processing manager will face the career choice already described.

END-USER COMPUTING

As hardware proliferates and as interconnection becomes more widespread, so the range of technical and application choices confronting users becomes ever wider and more difficult to evaluate. This topic was examined in detail in Foundation Report No 30, — End-User Computing. What equipment to use? Which packages or system generators? Which data management system? Which communication protocols?

In the short term one of the chief priorities of the information systems manager will be to set up centres of expertise to provide such guidance to end users. Moreover, the internal market for such guidance and practical help will expand rapidly during the next five years. Today the users who employ such services are mainly professional and technical — accountants, engineers, designers. In the future, hands-on users will include all specialisations and all levels.

As the numbers of users increase, so too will their level of awareness. As microcomputers invade office, factory, school and home, the data processing specialist will be advising a far more knowledgeable and canny customer base. The investment in system design effort to meet the increased expectations of such customers needs to begin now.

The methods of system development will change rapidly and fundamentally in the era of end-user computing. It will be as uneconomic for every user to be wholly dependent upon professional software development, as for every owner of a motor car to be wholly dependent upon a professional chauffeur. The short-term vehicles for the involvement of end users in system design are prototyping and application system generators. In the longer term, the selection of system building tools will be influenced more directly by the type of system being developed. Foundation Report No. 36 — Cost-effective Systems Development and Maintenance — identified and described the range of processes as traditional, iterative, collaborative and end-user processes. Managers and system staff were urged not to regard traditional system development as the only truly professional process, relegating the others to peripheral use. The report also envisaged that different parts of an application might be tackled in different ways.

THE PROFESSIONAL SYSTEM BUILDER

Foundation Report No. 36 also identified computer-aided tools that are now available to help analysts and programmers. For analysts they include application generators, high-level languages such as Mantis, and integrated toolkits such as All. For programmers they include program generators such as Delta, generalised software environments such as Unix and Pick, and programming workstations such as Maestro. As the quality of the available toolkits grows, Report No. 36 envisaged the reappearance of the programmer/analyst. The report identified productivity improvements of between 25 and 50 per cent obtainable by the use of automated system design methods. Initially the preserve of the professional system builder, these tools will later find their way into the hands of end users.

COMPUTERS, COMMUNICATIONS AND OFFICE SYSTEMS

Since the late 1970s, when the Foundation's first reports analysed the convergence of technologies, a great deal of organisational change and development has taken place. In those days we argued that, inside user organisations, the management of data processing, telecommunications and office systems was unproductively fragmented. We advocated unified management of these three services or, if that were impossible, at least close co-ordination.

Since then a measure of consolidation has taken place, mostly (it seems) with the effect of increasing the responsibility of the data processing manager. Over half the data processing managers in the 'Fortune 500' companies now have telecommunications managers reporting to them. All the powerful resources, however, are not necessarily in the hands of the data processing manager. Large dispersed organisations sometimes regard their communication networks as important company resources, and see as vital the task of reducing the number of separate networks to a single, corporate network. The department which creates and operates such a facility is a considerable force in any such organisation. We expect that telecommunications managers will become more concerned with the value and significance of communications, and less concerned with the mechanics of bit transport.

Office managers also have raised their sights and their budgets. They now generate demand both for access to company databases and for communication links. But most vendors of office equipment expect the final sanction for important office purchases to rest with the data processing manager in future years.

CHAPTER 6

GUIDELINES FOR MANAGEMENT ACTION

In this chapter we identify six key policy areas to which management should pay close attention in an era of fast-changing technology.

1. Watch for the key technology changes. Keep an informed eye, for instance, on the progress of the Japanese Fifth Generation Plan and on steps towards comprehensive standards for Open Systems Interconnection.

2. Keep up-to-date with long-term work towards improved software tools. The key task is to understand the structure of users' needs. This understanding will come only from patient thought and consideration.

3. Monitor changes in the shape of the budget for information systems. If trends continue, how may the budget look five years from now?

4. Extend the concept of the Information Centre to embrace more, and more senior, end users. Whether the support service to end users is called an Information Centre or not is not important. What matters is that it should seek out and stimulate users rather than simply respond to cries for help.

5. Identify key suppliers whose demise would prove embarrassing. Try to monitor their survival prospects by tapping sources of information. Investment analysts' reports are sometimes helpful.

6. Reflect upon the emergence of two roles for the data processing manager — director of technical services, and director of information. Can these roles reasonably be combined in your own organisation?

Finally we summarise in Figure 6.1 the major changes in information technology that we have identified in the preceding chapters. It is these changes that underpin our recommendations for management action.

Figure 6.1 Advances in information technology 1984 to 1988

The major changes at a glance

Good news

* Dual-processor computers give better reliability
* Images can be incorporated in office systems
* Standard interfaces make interworking possible
* VANs developments abound
* LANs and fourth-generation PABXs merge
* Value-added LANs emerge
* Voice recognition helps enquiries
* Voice synthesis answers enquirers
* Chips get cheaper, more powerful
* Demand even for central machines still grows
* Suppliers collaborate to survive
* IBM and the Japanese survive anyway
* Magnetic disc survives, optical for archives
* Data processing manager becomes technical supremo
* Users make more of their own systems
* Multi-vendor sites are normal
* Fibre optics threaten wire

Bad news

* No voice recognition of normal speech
* No revolution in expert systems
* Users learn fast — but not fast enough
* Fifth Generation Computer Plan disappoints
* Unix remains specialist tool
* Formal standards lag de facto standards

CHAPTER 7

CONCLUSION

The headlong progress of information technology continues unabated, and the impact of this progress is cumulative. In the years ahead we expect to see true 'electronic office' products being offered at attractive prices and with increased reliability. The ability of end users to satisfy some at least of their own needs will both stimulate the market for hardware products, and also further the development of the market for high-investment, multi-user software products.

Some Foundation members should act upon the guidelines in the preceding chapter to build a strategy, a strategy designed to avoid technical culs-de-sac and wasted expense. Such a strategy need not be a single-supplier policy, and the suppliers themselves understand why. Some managers within the Foundation membership will use this period of innovation and turbulence to extend their influence over the user environment: they will not directly control what users do, but they will control the context in which it is done. They will emerge more powerful from the rapidly changing world of the late 1980s.

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Butler Cox & Partners Limited
Butler Cox House, 12 Bloomsbury Square,
London WC1A 2LL, England
☎ + 44 1 831 0101, Telex 8813717 BUTCOX G

Belgium & The Netherlands
SA Butler Cox NV
Avenue Louise – 479 – Louizalaan,
Bte – 47 – Bus.
Bruxelles 1050 Brussel
☎ (02) 647 15 53, Telex 61963 BUTCOX

France
Butler Cox SARL
Tour Akzo, 164 Rue Ambroise Croizat,
93204 St Denis-Cedex 1, France
☎ (1)820.61.64, Telex 630336 AKZOPLA

United States of America
Butler Cox & Partners Limited
P.O. Box 590, Morristown, New Jersey 07960, USA
☎ (201) 285 1500

Switzerland and Germany
Butler Cox & Partners Limited
Butler Cox House, 12 Bloomsbury Square, London WC1A 2LL
☎ (London) 831 0101

Italy
Sisdoconsult
20123 Milano – Via Caradosso 7 – Italy
☎ 86.53.55/87.62.27, Telex 311250 PPF MI

The Nordic Region
Statskonsult
PO Box 4040, S-171 04 Solna, Sweden
☎ 08-730 03 00, Telex 127 54 SINTAB