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The Convergence of Technologies

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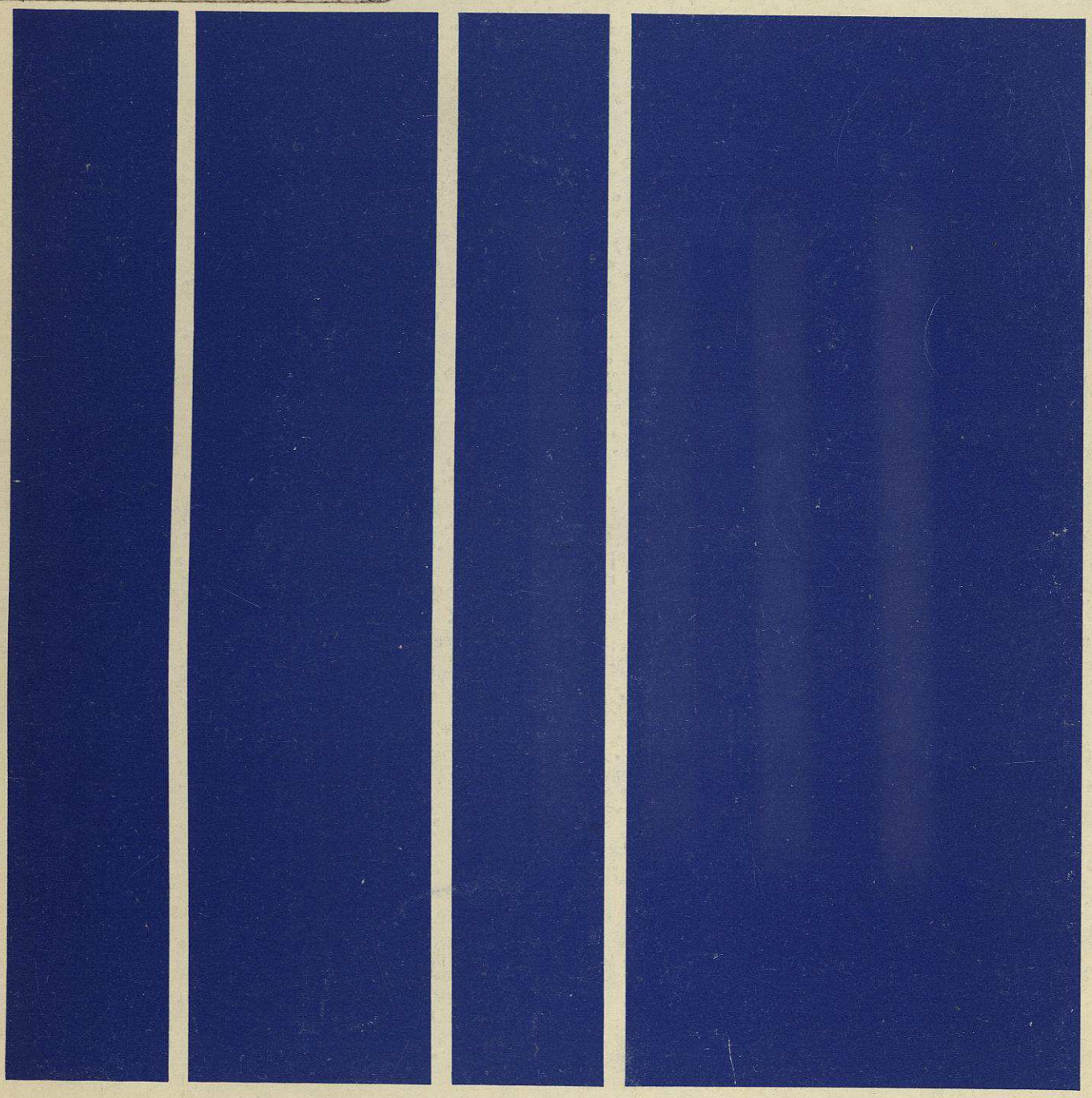

The Butler Cox Foundation

Abstract

Report Series No 5

The Convergence of Technologies

by David Butler
February 1978

The purpose of this report is to alert managers to a fundamental change in the way that information systems are conceived, designed and used, as a result of the so called 'convergence of technologies'.

The main components of a present-day business information system – apart from the human and organisational resources contained therein – are the products of three separate and previously non-competing industries. The most ubiquitous element is the ordinary telephone, providing both internal voice communication and external links via private and public exchanges. The second element is computers and (increasingly) microprocessors incorporated in other devices. And the third is the agglomeration of devices known as office machines – including typewriters, copiers, printers, microfilm, and paper storage systems. Convergence is the process by which these three industries are coming to depend upon a single technology. They are becoming, to all intents and purposes, *three branches of a single industry.*

This report presents a convincing overall picture of the changes which lie at the root of this movement. There is no doubt at all about the irruption of silicon technology into the communications and office products industries. There is no doubt at all about the seriousness of the challenge posed by IBM in the areas of private switching and satellite communications. And it is equally certain that competing products in the workstation market will come from all three industries.

The world of computers is faddy and riddled with unintelligible jargon. Every few years some new fashion seems to catch the fancy of the computer community, and for a time everything revolves around this notion. But they have had one thing in common: they have had virtually no impact on the world outside the tight echelons of the computer community. Convergence in contrast is already producing a reaction of a much more widespread nature. For this reason it is an important and enduring phenomenon rather than just a transient catchphrase.

This report describes the impact of convergence on suppliers and on users, and examines the US experience and the position of Europe. Finally it abstracts specific recommendations for management action in order to produce an instantly intelligible checklist of policy questions that need to be systematically reviewed. The report is intended to be read by managers of departments which *use* systems as well as by the managers responsible for *providing* systems – and by line as well as staff.

The Butler Cox Foundation

The Butler Cox Foundation is a research group which examines major developments in its field — computers, telecommunications, and office automation — on behalf of subscribing members. It provides a set of 'eyes and ears' on the world for the systems departments of some of Europe's largest concerns.

The Foundation collects its information in Europe and the US, where it has offices through its associated company. It transmits its findings to members in three main ways.

- as regular *written reports,* giving detailed findings and substantiating evidence.
- through *management conferences,* stressing the policy implications of the subjects studied for management services directors and their senior colleagues.
- through *professional and technical seminars,* where the members' own specialist managers and technicians can meet with the Foundation research teams to review their findings in depth.

The Foundation is controlled by a Management Board upon which the members are represented. Its responsibilities include the selection of topics for research, and approval of the Foundation's annual report and accounts, showing how the subscribed research funds have been employed.

The Butler Cox Foundation

The Convergence of Technologies

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I. INTRODUCTION

A Purpose

The purpose of this report is to alert managers to a fundamental change in the way that information systems are conceived, designed and used. It is intended to be read by managers of departments which use systems as well as by the managers responsible for *providing* systems – by line as well as staff. It may also be useful to offer this report to staff working in highly specialised areas, since the broad strategic picture is often hard for them to grasp. In order to be intelligible to the whole of its intended readership it largely eschews technical jargon, though an occasional reference to a particular device by its model number is regrettably unavoidable.

A spectre is haunting the manufacturers of computers, telecommunications equipment and office machines. It is the spectre of the so-called 'convergence of technologies'. What, to begin with, does convergence mean? Convergence is merely a shorthand term, a label which can be conveniently attached to the fundamental shift to be described in this report. It may or may not be adequately precise or significant: but it is beginning to be accepted and used, which is the only real test of a label.

What is convergence and why is it important? A brief description is offered here. A fuller explanation of the phenomenon and its implications will occupy the remainder of the report.

B The Convergence Of Technologies

The main components of a present-day business information system – ignoring for the moment the human and organisational resources comprised therein – are the products of three separate and previously non-competing industries.

The most ubiquitous element is the ordinary telephone, providing both internal voice communication and external links via private and public exchanges. The equipment used for this purpose is provided by the traditional telecommunications suppliers working within a framework laid down and regulated by the Postal, Telephone and Telegraph (PTT) authority of the particular country. In the past this business has been characterised as relatively slow-moving in technical and market terms. Because the PTTs largely determine the direction and pace of change, and because PTTs are large public bodies with complex social and political pressures to contend with, changes in the technology of communications and the patterns of market usage have come about very slowly. In the United Kingdom, for example, data communication (as opposed to voice) facilities have been available for many years. So slow however is the evolution of this market that data communication traffic still accounts for less than 2 per cent of the traffic of the national network. It is not that the PTTs strive actively to repress change: most do not. It is rather that as publicly accountable monopolies they cannot be expected to pioneer large-scale and often risky innovations. For this and other reasons the communications business has traditionally been stable, slow-moving and relatively predictable in its size and behaviour.

The second element in a present-day business information system is computers, including large mainframe devices, small computers and (increasingly) microprocessors incorporated in other devices. The main characteristics of this market are as different from those of communi-

cations as they could be. The market is very fast-moving. Every few years a new generation of technology emerges from the laboratories which obsoletes – or at least is claimed to obsolete – its antecedents. The write-off of computer systems is generally accomplished in 5 to 7 years as opposed to the 12 to 15 years of a private telephone exchange and the even longer life of an exchange in the public switched network.

The computer market is also relatively volatile compared to the communications market. Many large companies have changed their main computer supplier. Most use equipment from a variety of competing suppliers. Competition in the computer market is, despite periodic attempts by anti-monopoly agencies in Europe and the USA to promote civilised behaviour, virtually untramelled.

For the ordinary business user the volatility of the computer market has led to mixed results. He has a far wider range of choice in computer equipment (discs, tapes, printers and terminals as well as processors) than in telephone equipment where he must generally accept the PTT-approved monopoly product. Over the life of the computer industry, however, there must be serious doubts whether the pace of change has not been imprudently fast. As soon as one generation of systems is successfully implanted and operating satisfactorily, it is swept away on the tide of technical progress. Whether or not the computer industry can glean an adequate reward from its investment in succeeding generations, few indeed are the users who can claim to have done so.

The third element in the modern information system is the agglomeration of devices known as office machines – including typewriters, copiers, printers, microfilm, paper storage systems, etc. There is no single market for such products but rather an infinity of mini-markets, save in one or two areas where a unique advantage has accrued to a single dominant supplier. Such was the case of Xerox for many years as a result of its patents.

In so far as there is a particular dominant skill in the office machinery business, one skill the possession of which is vital to survival and success, it is the skill of selling to office managers.

The components of a modern business system are thus seen as the products of three very different industries. This fact increases both the dramatic significance of convergence and the scope of its impact, for the convergence of technologies is the process by which these three industries are coming to depend upon a single technology. They are becoming, to all intents and purposes, *three branches of a single industry.* We can begin our analysis of convergence – what it is and what it means – in a relatively gross fashion with some very obvious examples.

During the first 80 years of the life of the telephone industry both local and central switching were carried out by electro-mechanical means. Originally switching was accomplished manually, with operators working the switchboard. After the invention by Strowger of the automatic switchboard, subscriber dialling became possible. Acoustic signals travelling to the exchange trigger off the mechanical relays to establish a physical path from the caller to the called. The vast majority of the world's exchanges still operate in this way. But as long ago as 1965 the Bell Laboratories in the USA produced the ESS Number 1, the world's first electronic exchange. There are different types of electronic exchange and opinions vary about their relative merits. But they all establish the caller-to-called connection by the use of computer-like electronic circuitry. On one point all communications experts are agreed – that the electro-mechanical exchanges of the past are obsolete. The future lies with electronic (Stored Program Control or SPC) switches.

It is interesting to note that the Committee set up in Britain to review the operations of the Post Office visited some countries where SPC exchanges are already in use, such as the USA and Japan. The Committee reported that these new exchanges had achieved "a formidable list of plusses" including lower capital and maintenance costs and improved reliability. It is also worth noting that so similar is the technology of the computer industry to that required for the new communications world, that computer companies such as IBM and Nixdorf have

already diversified into the communications industry. We shall examine later in this report the significance of this diversification. Suffice it to note for the moment that the traditional communications manufacturers expect – and with good reason – that some of their main competitors in the future will be computer suppliers, whose diversification into telecommunications is a long-term and serious strategic move rather than just a flash in the pan.

What of the office machines market? A recent report of the Butler Cox Foundation (Report Series No 4) has examined the changes occurring in the market for office products. In short it is expected that such products will become more flexible in their uses and thus more economically attractive. The report forecast, for example, that we should soon see the emergence of a facsimile machine that also doubled as an office copier. As it happened, just such a device was launched in the USA within a few weeks of the report's publication. Another product which amply illustrates the flexibility of the new range of office products is the non-impact printer. Some such devices print on paper by squirting droplets of ink on to the paper surface. The shape of the character is formed by electronically deflecting the droplets. The importance of the ink-jet printer is that it can offer different type faces, upper and lower case, and even varying scripts such as Arabic or Cyrillic – all under program control. It is no longer necessary to have messy and inconvenient changes of the physical typeface. Once again, as with the communications industry, we see how the common factor of programmable control is of unique importance in the office machines industry.

When we speak of the convergence of technologies, therefore, we are really describing how the technology of the computer industry – silicon technology as opposed to copper wire technology – is invading two other industries. Because the computer manufacturers have a greater knowledge of and experience in their own technology, they have at least an initial advantage in its exploitation. In the next part of this report we look at factors other than technology which will influence the future of computers, telecommunications and office equipment.

C Convergence And The Market

We have just described how the underlying technology of the computer industry has begun to invade the communications and office products industries. If this were the limit of the significance of convergence, however, we should be justified in regarding it as an interesting but rather limited development. It would be comparable to the use of micro-processors in cars: as motorists we are interested in the prospect of a better car, but we don't expect Texas or Motorola to provide the main competition for General Motors in the future.

Convergence is a more serious proposition simply because it influences basically the structure of markets as well as their underlying technology. In order to illustrate this trend, let us examine one particular market – the European market for computerised private automatic branch exchanges.

A few years ago IBM decided to establish a research project into the area of voice switching. This project produced an early model known as 'Carnation'. It subsequently led to a later product known as the 2750 and later still to today's product, the IBM 3750. The world's communications firms responded for the most part with amused complacency to IBM's intrusion into this product market. They felt that it would be extremely difficult – or even impossible – for IBM to learn the skills required to operate successfully in the area of voice telephony.

They had two main reasons for believing that IBM would be seriously handicapped. In the first place the level of reliability required of a voice switch is very high indeed. Most computer installations can survive if a processor is periodically out of service, provided that the engineering support is good enough to get it back in service quite fast. But what happens when a telephone exchange is out of service? The effect on telephone users is instantly disastrous. The second source of comfort to the traditional communications suppliers was that IBM would

find great difficulty in learning to negotiate with the telephone administrations of the world. It is important to understand the role of the PTTs in this respect. Although in most countries they do not choose totally to exclude private suppliers of exchanges from the network, the PTTs can and do exercise the right to preserve 'network integrity'. This means that the PTT will test any proposed exchange to check that it is not dangerous to engineers working on the network, and to ensure that it does not interfere with the traffic of other network users.

Hidden beneath these apparently simple requirements is a vast mass of minute technical detail, large enough and complex enough to mean that even an experienced supplier would take a year or more and spend perhaps a million dollars securing just one administration's blessing for a new product. Could a computer manufacturer new to the communications business really hope to muster the expertise and resources required to conduct such negotiations simultaneously in a number of selected launch markets? Most people doubted that even IBM could do so.

To some extent IBM had outwitted its competitors by doing its homework *before* product launch. For it had carried out a comprehensive, world-wide study of the operational requirements of every public switched network in existence – a task of monumental size and complexity. Thus the 3750 was pre-designed to operate anywhere in the world without damage to network integrity.

In the event there were still some nasty shocks in store. The networks of the world have not been created instantaneously, but built up gradually over decades. There is not a telephone network in the world which fully conforms to its own specification. Engineers working far from headquarters introduce their own quirky innovations into the network. Decades later the firm installing a computerised exchange (which of course conforms exactly to the official specification) will have to learn to live with these quirks: IBM was no exception.

In the end the 3750 was successfully launched in most of the main European countries including France, the Federal Republic of Germany, Italy and the United Kingdom. Its sales success has been modest, except in the United Kingdom. But the important point is that the product was brought to the market with no greater fuss and bother than any experienced supplier would expect to suffer. Moreover it has consistently won its sales successes in competition with experienced communications suppliers, often because IBM's delivery dates were sooner and surer. Thus although no one could claim that IBM has made a great financial success of its entry into voice switching, and although its entry is so far limited to the field of private switching as opposed to public main exchanges, the important result is that IBM has become a communications company as well as a computer company. It is probably the world's first large company to have placed a bridge, albeit as yet a narrow and temporary one, across the gulf between these two major markets. Later in this report we shall examine how IBM is strengthening and widening that bridge, and how it is also buttressing its position in the office products market.

One further illustration of the impact of convergence on the world markets for computers, communications and office automation may be useful at this point. At the second Management Conference of the Butler Cox Foundation Dr. J. Evans of Standard Telephone Laboratories spoke on the topic of Novel Optical Components and Systems (see the Transcript, November 1977). Dr. Evan's paper lists some major application areas for optical fibre communications in the near future.

A fibre optic link is a length of very pure glass with a very low rate of signal attenuation. The refractive index of the glass at the core is much higher than that of the glass at the surface, so that any light in the fibre is reflected back to the core rather than dissipated to the outside world. The optical link, a long thread of glass, is now capable of transmitting signals – if only they can be inserted in the 'tube'. The coding and insertion of the signal is in fact carried out by means of a tiny laser, which is fabricated by a process of chemical deposition on a substrate. Dr. Evans's transcript contains pictures illustrating the structure of the laser: in effect it is like

a multi-layered sandwich, each layer serving a specific purpose to generate or control the lasing action.

Once the lasing action has been established, it can be electrically modulated to create the signal. The modulated signals pass down the fibre at the speed of light, bouncing off the reflective walls of the fibre whenever they are in danger of escaping from the tube.

No one doubts that there is a huge future for optical fibre links. The capacity of such links, either for speech or data transmission, is theoretically far in excess of the capacity of copper wires. They also have the advantage of being made from an abundant material, while copper is scarce. From a market point of view the significant fact is that the exploitation of the optical fibre has required the communication companies to plunge right into the silicon technology which the computer companies pioneered. The fabrication of the laser in particular depends upon methods initially developed for the production of magnetic storage media such as tapes and discs.

The logical outcome of current trends is the emergence of a market not for computer, communications or office products *per se* — but for information system components which exhibit the facilities of all three. Increasingly the technology underlying all three kinds of products will become common — silicon-based, capital rather than labour intensive, highly dependent upon design skills and upon the ability to assess very different markets. The new market will expose all suppliers to the need to satisfy the requirements of the end user, where some have previously been concerned only with selling to PTTs. As one manager recently remarked, "We are all systems houses now." In the next section of this report we consider the impact of these changes upon the suppliers, in preparation to assess the position of the end user.

II. THE IMPACT ON THE SUPPLIERS

A IBM

If IBM is taken as the first and foremost example of a computer supplier reacting to the convergence of technologies, and if it receives lengthier discussion here than any other, the reader should not assume any bias for or against that company. The Butler Cox Foundation maintains strict impartiality towards all suppliers. The fact is that IBM has reacted faster and to more effect than any other company to date, perhaps just because it has the resources to do what others only plan.

In the first part of this report we have already seen how IBM entered the field of voice switching with its Carnation project, embarking upon the line of development which later led to the 3750. Shortly we shall attempt to fit into place some other pieces of the jigsaw that is IBM's strategic response to convergence. But first there are some further points arising from the saga of the 3750.

As already mentioned, the sales success of the 3750 has been somewhat limited. We estimate that some 300 switches have been installed in Europe. The 3750 has never been released in the USA, which appears to reflect some doubts about its price-competitiveness against other American products (see for example the Transcript of the first Butler Cox Foundation Management Conference, May 1977, p.25 f.) There is, however, a puzzle here. Despite its modest sales performance the 3750 is treated by IBM very much as a flagship product. The large blue vehicles which transport the demonstration models are present, it seems, at every major European fair or conference. The marketing investment in the product appears to be enormous. In addition to the local marketing forces in the various countries where the 3750 is sold, there are national support forces stationed at La Gaude to handle the spectacular sales presentations mounted there for prospects who are flown in by private jet.

In view of the limited sales success of the product, how can one understand the very considerable prestige attached to the 3750? And how interpret the persistent rumour circulating in the second half of 1977 that the proposed successor to the 3750 – the 4750 – has now been cancelled?

Both questions are answerable only in terms of the convergence of technologies. The 3750 is a product of enormous strategic significance to IBM not because of its sales record but on account of its position in IBM's total product range, and because of the likely configuration of future office systems. The office terminals of the near-term future will be flexible devices with a range of facilities for the user – including text editing, data communication, voice telephony and ultimately graphics too (see Report Series No 4). The logic behind such devices is not merely technical but predominantly economic: the specialised, single-purpose devices of the past are simply too expensive, cost per function, to survive in competition with more flexible devices. Hence in the future the market for office products will centre around the so-called 'multi-function workstation'.

Such devices are now beginning to emerge from the research laboratories and find their way into manufacturers' catalogues. The facsimile/copier mentioned in Section I is a case in point. The fundamental feature of such devices is that, being capable of various functions, they will generate various kinds of traffic over the communications network of the host company. They

will produce voice, data, text and graphic signals. Even if this varying pattern of traffic is not handled by a wholly integrated network, which may be open to doubt, there remains a powerful argument in favour of a common system of wiring for all traffic passing between the multifunction terminal and the local controlling network node. If this argument prevails, then it is clearly of paramount importance for the terminal supplier also to be the supplier of the network node. Otherwise he risks having standards set for him in such areas as signalling, protocols and message formats which he must slavishly copy.

To this extent the local switch is the master component and the workstation the slave. It is for this reason that IBM has worked so hard and spent so much — and for a company so wedded to the philosophy of backing winning products and killing losers, the effort commands attention — in establishing the 3750 as a pace-setter. The purpose of the exercise is to acquire expertise and reputation as a company able to support integrated voice and data switching. How fast and how fully this aim can be advanced depends upon many factors. Some of the factors are outside IBM's control, such as the outcome of various regulatory and legal battles in the USA. We revert to some of these questions in Section IV of this report.

We must now consider the situation which arises if indeed the 3750 is the last voice switch to be designed and managed by La Gaude. The inescapable conclusion seems to be that IBM is planning the introduction of a switch capable of being sold worldwide rather than just in Europe. Such a switch would have to be price-competitive with current and future US offerings. Presumably it would benefit greatly from both the survey of world networks conducted before the 3750 launch, and from the expertise since gained in areas such as negotiations with the PTTs, and co-existing with the quirks of the public switched networks of the world. If past experience is any guide, the announcement of such a worldwide voice and data switching device may be expected shortly.

In order to understand IBM's posture in the era of convergence, it must also be appreciated that private switching is far from the whole of the company's ambitions in telecommunications. Another major plank in its strategy is its entry, in July 1975, into the business of launching and operating commercial satellites. In order to do this, IBM has banded together with a communications company and an insurance firm, with whom it took over a satellite operator called CML and renamed it Satellite Business Systems Inc. SBS has recently announced its plans to provide a trial service for a number of American companies. The services will permit both voice and data communication but will be limited to domestic traffic as opposed to international.

The significance of SBS in global terms is hard to evaluate. In some ways satellites are the most revolutionary development in the whole of modern communications, since they provide for the first time a channel of communication where the cost is totally independent of the distance between the sender and the recipient. Once a satellite is parked in a geosynchronous orbit, it is just as cheap to send a message from London to New York as from London to Paris. The bandwidth which is effectively available from a satellite can now also be greatly increased by means of a technique known as Demand Assigned Multiple Access or DAMA. Many subscribers can share the same satellite: the ground station in effect 'shouts' to the satellite when a subscriber needs a telephone circuit or a broad band data circuit. The required bandwidth is assigned for just as long as the subscriber requires it.

Some of the limitations from which satellites are alleged to suffer do not stand up to much examination. A great deal has been written, for example, about the liability of satellite channels to be disrupted by bad weather. It is true that certain weather conditions can disrupt satellite connections. But examination of the actual operating records shows that the consequent loss of service is less serious than that for most terrestrial links. Moreover, unlike the perils that afflict subterranean or submarine terrestrial links, bad weather conditions are predictable (thanks to satellites!) so that the same loss of service is less inconvenient when satellites are used, since standby terrestrial links can be arranged in time.

The greatest limitation on satellite usage is, objectively, nothing to do with the weather. It is the fact that only so many satellites can be used simultaneously before all the available bandwidth is used up. In other words it is the same limitation which restricts the number of radio or TV stations a country can have. Within this limitation it is likely that satellite communication will increase for purely economic reasons. It may be useful to illustrate the scale of these economic advantages with an example.

If a number of European companies were to band together (as IBM and its partners have done) and could gain permission to operate a satellite service linking fifty of their own offices within the EEC they could provide themselves with a very efficient service. Let us assume that they were *not* permitted to offer a service to any outside party. On current costs and making very pessimistic assumptions about utilisation, they would still gain a very economic service. The basic unit of charge by the United Kingdom Post Office is three pence. This unit buys a caller, as an example, approximately five seconds of connect time to the German Federal Republic at standard rate and some eight seconds during the off-peak night session. (These are, incidentally, among the cheapest international tariffs in Europe. The reverse call is much dearer). But the satellite system described above would give *over 300* seconds of connect time for the same price at any time of day or night.

These figures are even more remarkable if one reflects that they are based on current day costs. Yet the economics of satellites are due in the next few years for a further and very substantial improvement. The present technology requires us to destroy the satellite launcher in space when the satellite has been parked in its orbit. Imagine what the economics of voice switching would look like if, every time an exchange was delivered to a site, we blew up the truck that delivered it! As the trials of the space shuttle progress, so we are nearing the day when the launch vehicle will park the satellite and return to earth.

In order to exploit to the full the expertise it will gain through SBS on a worldwide scale, IBM would have to secure permission from the PTTs of the world to operate either domestic services or international links or both. At first sight this seems vastly improbable, since it involves the abandonment of the PTT monopoly in public transmission. But just as the telecommunications companies seriously underestimated IBM's ability to negotiate with the PTTs about the 3750, so we should be careful not to assume too glibly that IBM cannot at least dent this monopoly.

Yet even if IBM fails to become a common carrier it can still benefit greatly from the growth of satellite communications. PTTs will doubtless provide satellite channels more widely in the future than they do today, in response to the economic pressures described above. This will lead to a demand for on-site ground stations among the larger users. It is confidently to be expected that IBM will wish to be active in the business of building and supplying ground stations, either direct to the end-user or via the PTTs – as local regulatory circumstances permit.

The final weapon in IBM's arsenal, which it is mobilising to deal with the problems and opportunities of convergence, is its growing range of office equipment. The company is already well-established in this market, with its substantial lines of electric typewriters and office copiers. More recent additions to the product range include the ink-jet printer already mentioned in this report as well as display-screen word processing systems. These products are very important because they offer the chance for very imaginative combinations, under the control of the mainframe computer or the voice and data switch. The word processing system linked to the 3750, for example, gives the prospect of electronic mail in-house for the large user.

It seems clear that IBM's corporate strategy, whatever the details of interpretation may be, is to ride the crest of the convergence wave into a new and even more all-pervasive future. The company would like to be able to say (at least to its largest customers) that it can meet all their needs for information handling, whether these manifest themselves in the area of voice, data, text or image. It would not be inappropriate to substitute for International Business Machines the new name of the International Information Company. The main obstacles to the

achievement of this aim do not appear to lie in any weakness within IBM or any strength within its competitors. The company appears to have the products, the skills, the manpower, the strategic grasp, the tactical nous and the cash to make such an ambition eminently realisable. If it fails in its aim it will almost certainly not be because it loses out to its competitors: few have a strategy as clear and coherent as IBM's seems to be. Some have scarcely addressed themselves at all to the problems of convergence.

The main obstacle confronting IBM is the difficulty of securing approval for their services as they are framed in different countries of the world. Will the PTTs and the other regulatory bodies of the world allow them to innovate as they wish in the areas affected by convergence? IBM has some ideas of its own.

> "It is in the innovation of the new services we have discussed that I feel the private sector has the greatest and most effective role to play. Equally I do not feel this should be in any way exclusive, since I should like to see the Post Office given equal opportunity to market its own innovative ideas. It is here that the fundamental reasoning for the *separation of the management of the network and its use . . . . can best be appreciated* (our italics). Such a mixed environment would be rather new to the UK and the boundary between the two sectors will require most inspired and enlightened management.
>
> For the private sector I would argue that it has demonstrated its skills in creating new services and facilities for industry and the growth of our own sector of data processing is probably one of the most dramatic examples of the development of a new enterprise in history. Furthermore, I think the private sector has greater flexibility in its ability to seek, attract and use risk capital. Finally, it is able to attract, motivate and hold the entrepreneurial talents so vital in the creation of any new industry. This is particularly important in the task of *combining the resources and energies of the two important industries of communications and computing* (our italics) to the better service of commerce and industry generally and the greater prosperity of the community."

This passage is taken from the evidence presented by IBM to the Committee set up to report on the UK Post Office (Cmnd 6954, p. 426 f.) It is perhaps the clearest public statement ever made of IBM's intentions in respect of the convergence of technologies, which IBM defines as 'combining the resources and energies of the two important industries of communications and computing'. It is also a clear indication of the approach, constructive, low-key, socially creative which IBM intends to adopt (at least in one country and perhaps elsewhere) towards attaining its ambitions without a head-on clash with the local PTT. The approach is astute in terms of furthering IBM's ambitions. It has the additional merits of being extremely practical and forward-looking.

B Other Computer Suppliers

The convergence of technologies, with the imminent merger of three large and important industries into a single industry, has evoked from IBM the strategic response outlined in the earlier parts of this report. It is now time to ask what response the same circumstances have evoked from the world's other computer suppliers, who between them share some 30 to 40 per cent of the world market. At first sight the answer may seem very obvious – that few of the other companies have evinced any awareness at all of the new situation in which they find themselves. Closer examination will tend to confirm this view with one important proviso. For in fact most of the other companies are struggling to organise their policies in an area which is more short-term and immediate, namely the area of data communications pure and simple.

It may be helpful to explain in general terms what the problems of data communications are, and how they are currently being tackled. In this way it will be easier to understand the present positions of the computer suppliers, and how their strategic aims are conditioned by tactical constraints.

In some ways data communication is a trivial problem. If one looks for example at the revenues of the United Kingdom Post Office in 1976 (the latest year for which figures are available) one finds that the Post Office's DATEL or data communication services generated only £20m. of revenue. Other telecommunication services including Telex generated a total of £1,820m. Moreover although data communication revenue grew by some 53 per cent between 1975 and 1976, the corresponding rate of increase for other revenue was over 59 per cent. As a proportion of total Post Office revenue, DATEL actually declined in 1976. There is, however, more to this picture than meets the eye. For it is the volume of investment made by the user in services dependant upon DATEL that really counts, and here the Post Office estimates that over £1,800m. worth of data processing equipment is connected to the DATEL network. In addition it has been estimated that the application software developed by these users to run on their DATEL-connected systems represents an investment of around £1,000m. Thus DATEL, though a poor revenue-earner for the Post Office, is a vital link to support a business investment of close on three billion pounds. Although Britain, with 65,000 of Europe's 208,000 data connections as at the end of 1976, is probably Europe's most intensive user of data communications, the overall European position is probably fairly consistent – the importance of data communications lying in the volume of investment it supports. And since every single country in Europe except Finland has a higher anticipated rate of growth in data connections up to 1980 than Britain, the scale of the problem will certainly increase.

Now the computer manufacturers are aware that as the volume of investment supported by data communication services grows, so the pressure of public demand for improved services increases. The traditional means of providing a data communication service is to take a normal telephone line (or where necessary a line of greater speed) and to give the user a number of devices for converting the digital signals of the computer into the analogue signals of the telephone line and vice versa. The lines themselves may be either permanently leased to the user or simply dialled by him as and when he needs them.

In recent years, however, a solution has been sought to all the many problems that arise from providing data communication services in this way. Users often wish to connect terminals or computers of different types, speeds or makes. As volumes of traffic grow they wish to replace slower devices with faster. Some of the problems of interworking between different devices are examined in more detail in the Butler Cox Foundation Report Series No 3 on the subject of terminal compatibility. In order to respond to these needs the PTTs and standards authorities of the world have rapidly and more or less decisively opted for an alternative technology to the old-fashioned point-to-point connection. It is known as packet switching, and a brief explanation of it follows.

A packet is a kind of logical envelope that can be mailed through a computer network just as a letter is mailed through the physical system of postboxes, sorting offices and delivery vans – though rather faster. Like a physical envelope, a packet has a destination address as well as the sender's name and address, and a number of other coded items which help to guide it through the system and to ensure that no information is lost or gained en route. The intermediate computers between the source and destination examine each packet they receive and send each on its way.

During the past decade, packet switching has caught on in a big way. Originally the system was designed for military use, the idea being to provide continuing service on the surviving computers in a network that had been partially destroyed by nuclear weapons. Since the date of this apocalyptic vision, a number of packet switched networks have been devised to cope with more banal forms of unreliability. The most celebrated such network is the ARPANET in the USA, which links a number of computers in universities and other research institutions.

One of the major international standards-making bodies in the field of communications is the International Consultative Committee for Telephones and Telegraphs (CCITT). The Committee has recognised the possible advantages of packet switching and has published an international draft standard known as Recommendation X.25. A further important step is that several countries (including the Big Three of telecommunications, Canada, Japan and the USA) have

adopted this standard as the basis of their future networks. Moreover the European Community has made the same decision about its own major network, EURONET.

In order to grasp the significance of packet switching and its likely impact over the next five years, it is only necessary to tabulate the plans of the telephone administrations and authorised carriers of the world for its adoption:

COUNTRY	NETWORK	DATE OF SERVICE
Belgium		1980
Canada	DATAPAC	1977
	INFOSWITCH	1978
Denmark		1980
EEC	EURONET	1978
FDR		1979
France	TRANSPAC	1978
Italy		1980 or later
Japan	DDX2	1979
Netherlands	DNI	1979
Norway		1980
Spain	RETD	1973
Sweden		1980 or later
Switzerland		1978
USA	TELENET	1975
	TYMNET	1969

Source: CEPT

In the United Kingdom no firm plans have yet been announced for a public packet switched data network. In April 1977 an experimental system was launched with centres in London, Manchester and Glasgow. Because it predates the CCITT standard, this experimental service is not designed on the basis of X.25. In order to obtain expert advice on the situation, the British government set up a National Committee on Computer Networks with a small permanent secretariat and a highly distinguished and knowledgeable membership. Although the work of the Committee in fact-gathering is still in progress, in November 1977 it published an interim report. The report shows that the Committee's final recommendations will almost certainly entail the creation of a national packet switched data network.

The current situation in respect of packet switching poses two serious questions for the computer manufacturers. One is short term and the other long term. In order to understand the apparent lack of response to the convergence of technologies on the part of the computer firms, it is vitally necessary to understand these questions. Both have crucial ramifications for the future of the computer industry.

Let us first examine the short term problem. By 1980, as the table shows, there may be as many as sixteen public packet switched data networks in operation in the world. If the UK follows suit, the total will be seventeen. Other nations will doubtless scramble aboard the packet switch band wagon as time goes on. If, too, all these networks are based upon the international X.25 standard, then many of the problems of international data communication will also be eased. Now the provision of basic data communication services, in the current limited state of the art, represents virtually the whole of the computer suppliers' market in the telecommunications business. The crucial question in the short term is therefore how successful these systems will be in absorbing the business of the ordinary computer user.

There are two extreme views. The first is that the PTTs will make a public monopoly of data communications and simply destroy a substantial chunk of the suppliers' business. The PTTs would argue that the provision of a public service makes it unnecessary for private networks to be established and would phase out the provision of the private leased lines upon which

such networks depend. Alternatively they might price such links out of existence. Moreover they would argue that, since many of the public data bases now being established in Europe are packet switched (e.g. Euronet) the existence of a public packet switched service is an essential gateway to these facilities. Such a future would hold grave risks for the world's computer suppliers. The development and marketing costs of data processing devices are high. If there is a single world-wide standard interface (X.25) and a single packet format to observe, customer fidelity is much reduced because changing devices would become so much easier. How would the suppliers have any certainty of a reasonable product life?

The second extreme view is based upon a more jaundiced appraisal of packet switching and a more cautious assessment of the ability of the PTTs to meet customers' needs. This alternative but equally extreme scenario runs as follows: the PTTs will provide customers with a flexible inter-connection facility based on X.25, a complex and costly facility based on a technique devised for military and research applications. Such a service is wholly unsuited to the commercial computer user, most of whose traffic is from site to site within his own organisation. He simply doesn't need anything as complicated and expensive as packet switching, because he can control the rate of change on his own sites. To maintain order in communication between his own sites he needs a basic network operating system that the computer supplier can give him, exploiting the features of his particular network. He will change his network in a planned way over time. He doesn't want to spend a fortune to insure his network against nuclear attack. According to this view, the customers will vote with their feet. They will not use the packet switched data networks. The PTTs will be obliged to continue the provision of leased lines for private networks and the packet switched data networks will be gently run down.

This is the short term predicament facing the computer suppliers. They have an existing investment in the kind of system the second scenario favours, the limited and device-oriented network control system. Should they increase that investment in the expectation that a substantial part of their market will remain intact? Or should they be planning how to survive in a world dominated by X.25 and its historic developments?

In time the advent of public digital networks for voice communication (such as the UK's System X) will render all such debates obsolete, as fast circuit-switched channels become available for all kinds of traffic. But this will not be the case until the late 1980s or early 1990s. What happens in the meantime?

IBM has already made its short term choice, as can be seen from the way that it plans for the X.25 standard to work alongside its own system — Systems Network Architecture or SNA. One of the important features of a packet switched network is known as 'flow control'. This feature is designed to ensure that, in addition to individual packets being properly secured, the overall flow of packages is correctly handled. Thus if a particular transmission from A to B consists of ten packets, flow control will check that they are assembled in the right order at their destination. This feature is one of the complexities for which the user pays an extra premium in a packet switched network.

Under SNA however the X.25 commands are intercepted by IBM's own software and are partially stifled. One IBM user can call another across the proposed public X.25 network, but he cannot use the full features of the system. Thus although IBM can be said to support X.25, it prefers to keep it in a role subordinate to its own system. This may suggest that IBM regards the second of the two short term scenarios as the more probable.

The longer term question facing the computer suppliers now demands our attention. We have already seen in earlier sections of this report that the future of office systems will lie with devices capable of more than a single function, leading to the multi-function workstation. This development leads in turn to the generation of mixed traffic loads on the lines connecting the terminal to its local network controller. Such traffic may ultimately include voice, data, text and image signals. If this is an accurate assessment of the future trend in office equipment (and it rests more heavily upon an economic appraisal of the needs of the user than upon mere

technical forecasting), then is there not a case for a unified public switched network rather than a separate public data network? Such considerations create a degree of uncertainty in the minds of the computer suppliers about the wisdom of longer term investments, in addition to those provoked by the imminence but possible impermance of packet switched networks.

Whatever the underlying causes of their uncertainty – and as we have seen there are valid questions as yet unanswered – there can be no doubt that most computer manufacturers are beginning to suffer material damage as a result of their inability to come to grips with the problems and opportunities created by convergence. Even a cursory inspection of the customer list for the IBM 3750 private branch exchange shows that many organisations who have never been users of IBM's mainframe computers have bought the switch. It will doubtless provide adequate or even excellent service in an area which is highly visible to the non-technical manager, his ability to make or take a telephone call with speed and efficiency. The 3750 has been described as IBM's Trojan horse, because it has gained them access to customers who were not open to a more frontal approach such as mainframe computers. The company can be relied upon to deploy its customary standard of sales skill in attempts to widen the breach it has created.

Probably the most important adjustment that most computer suppliers need to make in the light of convergence is one of attitude, pure and simple. There is a tendency, natural enough in the past, for computer suppliers to regard the central processor as the nucleus of a company's information system. All other devices, including storage media, printers and the end-users' terminals, are defined in relation to the central processor. Ask most computer manufacturers to draw a map of the universe and they will place the processor at its centre. To them a voice switch (even if it also has capabilities for switching data) is just another peripheral device which may require time and attention from the central processor.

In fact, however, the system design criteria of the future will be very different. The advent of distributed processing will in any case destroy the concept of intelligence as a solely centralised resource. Processor power will be much more widely scattered over the network as a whole. In addition, however, as applications such as communicating word processing, electronic mail and electronic funds transfer become more widespread, the critical ability of the system changes. The one vital question which users will ask is this: can the system provide me, rapidly and effectively and at a price I can afford, with a communication channel to the resource I want to contact capable of handling the traffic I plan to generate? To this extent the systems of the next decade are much more dependant on *switching* than on any other function. The old computer-centric vision of the world is wholly irrelevant to this new perspective, and indeed is positively inimical to its proper comprehension.

As ever, the conceptual revolution is the hardest to assimilate. When Copernicus published the "De Revolutionibus" in 1543, arguing that the earth revolved about the sun rather than the reverse, the Ptolemaic astronomy was dead and buried. But it must have required an enormous intellectual effort on the part of Copernicus's contemporaries to grasp the implications of the theory.

Unhappily today most computer suppliers seem unable to grasp the reality of convergence *as a concept.* IBM stands out as the only company to have a clearly perceptible strategy, although that strategy may have certain weaknesses.

C Communications Companies

Any attempt to assess the impact of the convergence of technologies on the classical communications industry must also take account of the other major changes which are occurring in the industry. For however rapid the pace of change in the computer industry, it is probably true that changes in the telecommunications industry are even more rapid.

Looking at the general economic situation of the industry, it is immediately obvious that

serious problems exist. The industry has been called upon to deal with extremely violent fluctuations in demand. In the late 1960s, for example, many of the world's PTTs were ordering new plant and equipment almost as fast as the industry was able to produce it. Almost all of this equipment was of the old-fashioned electromechanical variety, which is highly labour intensive to produce and to maintain. The purpose of this rapid expansion in public network capacity was simply to keep pace with the growing demand for telephone service generated by the worldwide economic expansion of the 1960s.

The communications companies thus entered the 1970s suffering from what would later be seen as certain major strategic weaknesses. Because they had maintained full order books as a direct result of large public expenditures, without the requirement to undertake any extensive marketing or sales activities of their own, their skills in this direction had become somewhat atrophied. Because the products they were making were based almost wholly on existing technology, there had been little incentive to carry out systematic research into new technologies. And because the demand for those products appeared almost inexhaustible, as telephone penetration and usage organically grew, there was little incentive to look at the reduced manning levels which newer technologies had already made possible.

The world economic recession triggered off by the energy crisis in 1973 thus found the telecommunications industry in Europe in a very difficult position. As public expenditure in most countries was cut back, the industry was left with excess capacity to add to its other problems. In order to understand these problems it is necessary to examine in outline the main developments in telecommunications in North America during the past decade, for it is these developments which have shaped the strategic environment within which European companies must operate today.

Any survey of the American telecommunications industry must take as its start point the working group set up in the late 1960s by the then President Richard Nixon. The findings of this group and subsequent legislation based upon them have substantially altered the face of the American communications industry and thereby created a new worldwide environment.

For all practical purposes the dominant force in North American telecommunications has been a single company – AT&T. The Bell System, the various Bell operating companies and the manufacturing subsidiary Western Electric are all dominant forces in their respective sectors. Only by operating as multi-national companies in the markets of the world have other American companies been able to prosper in the shadow of Bell.

An obvious question for President Nixon's task force was the extent to which the monopoly position of AT&T was in the interests of the American consumer. It was not, of course, the first time this question had been asked; indeed AT&T has been the subject of numerous anti-trust actions over the years. The working group expressed its findings in a very forthright manner:-

> "We are guided by the basic premise underlying the law and policy affecting industry and commerce, that unless clearly inimical to the public interest free market competition affords the most reliable incentives for innovation, cost reduction and efficient resource allocation. Hence, competition should be the rule in telecommunications and monopoly the exception."

Two major policy innovations stemmed from the application of this underlying premise. The first, known as the 'foreign attachments' ruling, was also reflected in the famous Carterfone decision. In brief the new policy implied that provided a standard interface adaptor was used to connect a device to the public network, subscribers had the right to attach their own equipment. The role of the common carrier is seen as bringing the network to the subscriber's door. What happens on the other side of the door is the subscriber's business.

It is important to understand the difference between the post-Carterfone position in the USA

and that which now prevails in most European countries. The following summary of the position now in the USA and in Europe is taken from the evidence submitted by the Telecommunication Engineering & Manufacturing Association (TEMA) to the Post Office Review Committee in 1977.

In the USA the governmental authority is the Federal Communications Commission (FCC). A number of major companies such as Bell and GT&E together with a large number of small independent companies have been granted monopoly powers to provide public exchange services in specific geographic areas. Since 1968 the subscribers' systems market has been completely liberalised. Any private contractor is allowed without license to provide Key, Call-Director and PABX systems for sale, lease or rent. Residential telephone services remain a monopoly of the local Carrier. After-sales maintenance of all the free market products as well as associated extension station line-wiring and equipment can be provided by any kind of private contracting company. The TEMA evidence goes on to mention ten other countries with similarly liberal policies, and goes on to cite many claimed advantages for liberalisation not only to the subscriber but also to the carrier in the form of increased traffic.

In sharp contrast the TEMA evidence summarises the position in Western Europe generally and certainly in its major nations. The following table illustrates the differences:-

Supply of PABXs in the EEC

Belgium	A		C	D		F	
Denmark		B	C		E	G	Must be Crossbar
Eire	A			D		F	
France	A			D		F	H
W.Germany	A		C	D		F or G	
Holland							Complete Monopoly
Italy	A			D		F	
Luxembourg	A			D		F	
UK		B	C		E	G	Only 50 lines and upwards. Associated telephones and linewiring provided by BPO.

Key:
A. Equipment rented or sold by private contractor
B. Equipment sold by private contractor
C. Private contractor has to be authorised
D. Equipment must be approved
E. Equipment must be of approved design
F. Equipment maintained by supplier
G. Equipment maintained by authority
H. Local manufacture or assembly required

Source: Appendix to the Report of the Post Office Review Committee, Cmnd 6954, November 1977.

It is not the purpose of this report to argue the case for or against a change in the practices governing attachments to the public switched networks in Europe. That argument, though indeed fascinating and important, is not germane to the subject of convergence. It is, however,

relevant to emphasise the difference in outlook and experience which the different environment of the USA has engendered in its telecommunication suppliers, as compared with their European counterparts. For the best part of a decade the US suppliers have been accustomed to operate in a free market, bringing their products to fruition as fast as they are able, analysing and assessing the needs not of the large monopoly purchaser such as the PTTs but of the manager who has a problem to solve, and fighting to cut their production and labour costs to competitive levels.

Even without any changes in the regulatory structure in Europe, the skills which the American companies have evolved in response to a free market are exceptionally valuable. As the convergence of technologies drags the communication companies into competition with IBM, so their need for skills in fast product development, market analysis and cost reduction become more urgent. That European companies recognise this need, and accept that for the moment the American environment has served better to train its suppliers for the new markets, is clear enough. Two of Europe's best established communications companies have signalled their acceptance of these facts of life by acquiring the rights to adapt and market North American products in Europe.

The above paragraphs were intended to highlight the effect of the foreign attachments ruling, in preparing American companies for the future markets. But this was only one of the two major policy changes that stemmed from the findings of President Nixon's study group. The second related to communication satellites, where a similarly competitive situation was encouraged. This decision, as we have already seen, has opened the door for IBM to enter the field through the medium of Satellite Business Systems Inc.

Summarising the position of the European telecommunications suppliers, we see that they currently have serious problems to grapple with. They are facing a revolution in their own business as stored program control exchanges, digital transmission of voice telephony, new transmission media such as satellites and optical fibres and new public services such as Viewdata clamour for their time, attention and investment. They are also facing a difficult period of transition in terms of the cost structure of their industry. The man-hours per line required to build an old-fashioned step by step exchange were 25: the corresponding figure for a modern SPC exchange is 3. Even with an increase in total sales volumes it is inevitable that there will be painful surpluses of labour in the industry as the old technology gives way to the new. And in addition to all this, the convergence of technologies is opening up new competitive challenges which they must also face.

Undoubtedly the communication companies will continue to overcome their problems and to prosper. From a strategic European point of view, it is inconceivable that they would not be permitted to do so. Yet it is as well to recognise that the management skills they require over the next decade are of an exceptionally high order, and that they have a right to ask the cooperation of the European PTTs and supra-national bodies while they are resolving their problems.

D Other Entrants

The computer companies and the traditional telecommunications companies are not the only contenders in the race to benefit from convergence, though at the moment they occupy the best positions on the track. Some of them are privately worried by what is known as the 'Swiss watch' syndrome. It has been argued that when a radically new technology arises, it is new firms rather than the established leaders in the old technology who are best placed to exploit it. The old leaders are blinkered by their adherence to obsolete technology and fail to grasp the significance of the new. The *locus classicus* of this syndrome, as its name implies, is the failure of the Swiss watchmakers to adapt to the advent of the digital watch. Perhaps in the same way there are dark horses waiting to exploit convergence. Perhaps a decade from now some of the leading companies in the market will be firms we do not presently recognise as contenders.

It is as yet too early to pinpoint particular firms with the potential to make a serious impact in the market. From a technical point of view there are some whose names spring to mind. In the USA a tiny company named Rolm has produced an advanced private exchange which is now being marketed in Europe. Two other US switch manufacturers who are not yet widely known in Europe, Wescom and Danray, have also produced computerised branch exchanges with exceptionally interesting capabilities. Report number 3 in the Butler Cox Foundation series highlights (p. 18 f.) two important attempts to achieve better interworking through terminal compatibility: one is from the Norwegian company Kongsberg and the other from Megadata in the USA. So there is no lack of smaller companies bringing off interesting developments in areas on the margin of convergence. What we cannot yet tell is whether any of them has the marketing flair, global ambition and negotiating skill to make more than a marginal impact.

A further category of possible entrants is the component suppliers. One of the main unanswered questions in the computer industry today is the possible future impact of vertical integration. The component manufacturers can now put very considerable computing power on a single chip. Traditionally they have been content to act as component suppliers to the computer manufacturers. But in the future will they see themselves as competitors? They after all have taken on the main burden of securing reliability and good yields in the batch fabrication of computers. They may feel that they are entitled to a bigger share of the cake.

It is instructive to look at what happened in the electronic calculator industry between 1966 and 1974. In 1966 the market for calculators in the USA, for example, was the preserve of the American suppliers. Four years later a remarkable change had occurred. The Japanese share of this market had risen to 40 per cent by value, an export market worth $90m. to Japan. In 1971 Japan's share of the US market had risen further to 60 per cent by volume and 45 per cent by value. But by 1974 a further change had occurred. Although the total US calculator market had risen by 235 per cent between 1970 and 1974 the Japanese share had dropped from 40 per cent by value to only 21 per cent. American suppliers had fought back to regain a market which might have looked lost forever.

One of the main reasons for this reversal was the entry into the market in 1972 of the component suppliers such as Texas Instruments, Rockwell and National Semiconductor. They had the advantage of acquiring components for calculator assembly at a price no other suppliers could match.

As the process of convergence advances and the spread of convergence silicon technology widens, the same firms will doubtless be tempted to apply their advantage in other product markets.

Probably the most likely strategic route to the applications of the future, where voice, data, text and graphics processing are under the control of a single operating system, is the route that passes via communicating word processors. It is worth while to explain this application area, in view of its probable future importance.

Modern word processing systems provide a display screen, a keyboard, a printer, a memory system and a processor. The users compose their text via the keyboard on to the display screen. Only when they are fully satisfied with the accuracy and layout of the text do they order the system to print their text. The text can also be stored in the memory system, the most common medium being the diskette. Standard letters to be sent to many recipients can thus be automatically run off from a name/address file, each one being a top copy. Alternatively the text of a long document can be stored and successive drafts produced automatically, only the changed portions requiring to be re-typed (see the Butler Cox Foundation Report Series No 2).

The main purpose of word processors is to increase the productivity of secretaries and typists. This is the basis upon which the equipment is sold. It is, however, obvious that as such devices become commonplace they can serve an additional function. In large organisations a substantial

proportion of the total mail handled by the clerical staff is internal, generated in other offices of the same company. A great deal of time, cost and effort can be saved if word processing machines are linked via a switching system. Messages travelling from one part of the organisation to another can appear as text on the screen rather than as hard copy. The problems of setting up electronic mail systems between senders and recipients in different organisations are more complex and depend heavily upon the agreement of the PTT. But there is little doubt that such services point the way ahead to the office technology of tomorrow.

The report cited above tabulates (pp.19 and 20) the main features of fifteen products from the leading suppliers of text processing equipment. Among the large companies which have active subsidiaries or divisions at work and which also have sufficient marketing and investment capacity to make an impact are IBM, Exxon, Xerox and Texas Instruments. No single company yet has a decisive lead in the market.

III. THE IMPACT ON THE USER OF SYSTEMS

A Systems Of The Future

In this section we turn to the impact of convergence on the user of systems. An overall picture is given here, and some of the main policy questions are raised. In Section V we offer some short guidelines corresponding to the policy questions.

The dominant factor governing the design of systems in the past has been the relatively high cost of hardware. When the computer and its associated peripherals represented around 60 per cent of the data processing budget, it was natural for systems to be designed in a computer-centric fashion. The touchstone for economic effectiveness was to achieve a high rate of utilisation of the expensive capital asset. For this reason systems were designed around the implicit assumption that people (both the system operators and the system users) could be made to fit in with the requirements of the machine.

This design principle, which may have been a perfectly reasonable reflection of economic realities in its time, lay at the heart of much of the dissatisfaction expressed with information systems. To the end-user, the manager with a problem, the system often seemed alien and remote – something 'over there' to which he could have only limited access, and that at times and in ways that were rigidly controlled by the computer department. A computer manager in the early 1960s expressed to the author his misgivings over the impending installation of remote job entry terminals. "We have always run a very tightly scheduled operation. Now we face the danger that users will insist on running jobs to suit themselves, however hard we try to discipline them." In other words he was alarmed that managers might try to use the system when their business needs prompted them to use it, rather than when it was convenient to the computer department to have them use it. The constraints imposed by the economic realities of the past were seriously inhibiting. They made it almost impossible for the end-user to regard the information system as his own.

Because of changes in the cost structure of the computer industry, this particular constraint is about to be progressively slackened and ultimately lifted completely. The changes in the cost of processing power and storage capacity are evolutionary in the sense that they have been in train for many years; the dramatic changes of today are the result of progressive trends over time. But these changes are revolutionary in their impact; there is a point where quantitative changes in the cost of a commodity become qualitative in their impact on a market. Computing power now stands at that point.

A few examples may serve to illustrate the point. At the second Management Conference of the Butler Cox Foundation, Mr. Derek Roberts offered such examples (see the Transcript, November 1977). He showed how since 1960 the price per logical gate in semiconductors has declined from around $100 to around 0.1 cents and how in the next two years it is expected further to decline to around 0.01 cents. In terms of memories, he also showed the progressive increase in the number of bits per chip, from a single gate in 1962 to a 32,000 bit Charged Couple Device and a 16,000 bit Random Access Memory in 1978.

In cost terms Mr. Roberts contrasted the cost and capacity of six different storage technologies. They all conform to the general rule that economies of scale prevail. While small random access memories with very fast access times remain relatively expensive at around 10^{-1} cents per bit,

slower disc and tape media offer prices of 10^{-3} cents per bit. It is forecast that very large laser-driven holographic memories will offer 10^{-5} cents per bit provided the scale is large enough.

These trends mean that the purely hardware element in data processing budgets is likely to level off as a proportion of total expenditure. Moreover, as the processors and storage media of the next few years become markedly cheaper, there will be an increasing trend away from centralised systems. Increasingly, computing power will be placed in the hands of the end-user, the manager with a problem. Thus the new technology will usher in the much-heralded era of distributed processing.

How will these cost changes effect the end-user in the era of convergence? There are two main problem areas which need to be addressed, and they are related to each other. The first is concerned with the degree of complexity built into the systems of the future. Up to now the suppliers of computers have tried to make their products 'easy to use' by providing massive and highly complex internal operating systems. These systems governed the response of the computer to competing claims for attention, the scheduling of jobs, the maintenance of files and so forth. They have become exceedingly onerous for the user — often the largest single task for the system being its own housekeeping.

Consider then the opportunities for further complexity offered by the impending changes. Imagine a system of distributed processing, with terminals scattered over a large organisation. Imagine that these terminals exhibit some of the characteristics of the multi-function work-station already described, including the ability to handle voice, data, text and perhaps graphic messages. It is at once obvious that the operating system to control such a network could very easily become even vaster and infinitely more complex than the networks of today. It is important to note that although the operating systems of today were designed to make systems easier to use, they have in practice achieved the opposite result. Many of today's computer staff have had to be trained in the *internals* of operating systems, since without such knowledge they could not understand what the system was doing. This situation means that not only for the end-user but also for many of the computer staff themselves the system is remote, alien and 'over there'. There can be little doubt that the advent of convergence offers an opportunity, if past trends are not checked and reversed, for systems to become even more mind-bogglingly complex and even more unapproachable. Over the next decade one of the main criteria for assessing computer suppliers should be the strength and clarity of their determination to avoid this most undesirable situation.

The second (and related) problem to which users must address themselves is the cost of system development. As the proportion of total expenditure devoted to hardware stabilises, so the costs of manpower — systems analysts, programmers and operators — will in turn become more significant and more visible to user managers who foot the bill. This point is related to the preceding argument by virtue of the greater difficulty of designing and implementing applications for very complex systems.

At present the development of software systems is, as an exercise in applied human ingenuity and intelligence, extremely unsatisfactory. There is little in the way of standard engineering techniques such as one would expect. A sceptical user might be forgiven for believing that every application, even those very similar to others already undertaken, was invented from scratch as though it were unique in the experience of mankind.

There are in progress around the world many attempts to come to grips with this problem of high development cost. Universities such as Michigan and the London School of Economics have long-term research programmes devoted to the problem. At least one US computer manufacturer (the Logical Machine Company) offers a system where the user himself sits at the keyboard and builds his system by progressively defining its elements, without the intervention of a professional programmer. Another (Jacquard Systems) has commissioned a series of system packages from a software house where the user generates his application by completing a set of parameter sheets. (IBM's System 32 was the pace-setter in such development aids). The

efforts of other computer manufacturers have been directed largely at improved productivity of programmers, which is only one part of the problem.

During the next few years we can therefore expect to see greater emphasis placed upon the need for better and cheaper tools for system development. If the evidence of the past is any guide, progress in this direction will be gradual rather than sudden.

B Planning For Convergence

In the earlier sections of this report we have tried to assess the impact of convergence upon the suppliers of computers, communication systems and office products. In the preceding part we have described the other factors likely to be of fundamental importance to the user of systems in the next few years. We can now move towards a definition of the prudent user's response to this situation. In this section we propose ten policy areas in which every large organisation should begin to examine its performance, clarify its thinking and seek gradual improvement. These policy areas align with the guidelines set out in the final section of the report.

1 Network design

Network design is a large and complex area, posing many problems such as security, utilisation, terminal compatibility, signalling, protocols and message formats. Many of these topics have been or will be discussed in Foundation reports. For illustrative purposes only we take here two particular examples of network problems, namely the features of computerised exchanges and the shared use of lines for data and voice traffic.

Most large companies now possess some form of network for voice and/or data traffic. Over the next few years many will embark upon studies to enhance or modernise these networks. Most such studies will involve the evaluation of equipment which is novel to the company, such as computerised branch exchanges.

There are many important lessons to be learned. The system facilities of computerised switches, such as those which monitor network traffic and allocate costs to the departmental budgets of telephone users, vary greatly in usefulness. Class of service restrictions, which prevent unauthorised external or international calling, may be an important tool in cost reduction or just an irritant. Automatic call routing, which means that only calls from senior managers are allowed to use public lines while others must wait for a tie-line to be free, also has an impact upon cost and level of service. Similarly the features of such systems designed to help users require careful evaluation. Many such features are offered and feature prominently in the sales literature. But how useful are they in practice? At the offices of a communications company recently, the author of this report observed a sign enjoining managers to keep their secretaries informed of their whereabouts. Some puzzlement ensued, since the office was equipped with a computerised exchange offering a 'follow me' facility, so that calls to a given extension could be automatically diverted to another. The explanation offered was that although this facility indeed existed, no one could remember the code to use it.

Perhaps the most awkward problem to resolve in current network design is the extent to which shared facilities for voice and data traffic are feasible in any particular case. Where for example leased telephone lines exist for voice communications, there is a pronounced tendency for the network to 'go to sleep' at night. Since rental is paid for the lines on a 24-hour a day basis, this is grossly uneconomic. In many cases, however, it is difficult to take advantage of this unused capacity. The peaks of voice traffic traditionally occur in the late morning and early afternoon of the working day. These can all too easily coincide with the peaks of data transmission too, thus only increasing the extent to which the network is over-engineered in relation to total traffic.

2 Multi-function workstations

Over the next few years we shall see a tendency for a wider variety of office functions to be included in the same device. The economic importance of this trend for users will be

considerable, since it will encourage the replacement of expensive, single-purpose devices with equipment which is much cheaper in terms of cost per function. Three kinds of activity will pay off for the careful manager. First he should maintain his awareness of the new products as they reach the market, and seek to monitor the experience of their earliest users. Secondly he should try to obtain or maintain control of the fragmented expenditure on single-purpose devices such as copiers, facsimile tranceivers and telex machines. One of the keys to the subsequent replacement of these devices will be just knowing where they are and how much they cost. Thirdly, and the most difficult task, he should try to plan his network extensions with the multi-function workstation in mind. This is far from easy, since the precise characteristics of future products cannot be known in advance. But if, for example, he is planning to install interactive data terminals at a site in 1978 it may be imprudent to plan for stand-alone word processing at the same site in 1979.

3 Switching

Few areas will reward such careful study and consideration in the next decade as that of switching, and its significance for the development of systems. It is as well to reiterate the chain of logic that leads to this conclusion, since it is of fundamental importance.

Computer systems of the past have barely scratched the surface of the problem of clerical labour costs. A survey of an American company only a few years ago showed that over three-quarters of total administrative costs went on clerical labour as opposed to systems or equipment of any kind. The reason for this disproportion lies in the low productivity of office staff, by any criterion far below that of manufacturing labour. And the reason for low productivity is low investment, based upon the inability of managers to get an adequate return upon special-purpose expensive devices.

Now the logic of this analysis points to the multi-function device as the key to improved productivity in the office, since it will encourage the degree of per capita investment needed. But the multi-function device will generate mixed traffic including potentially voice, data, text and graphics. The only way such a pattern of traffic can sensibly be handled is by fast and flexible switching. Hence the switching function is central to increased productivity and better labour costs.

A number of important developments can be foreseen in the years ahead. Companies whose products are currently concerned solely with voice switching will doubtless release switches with data capability, either through an integrated switch or an add-on box. Some of the advanced products now available in the USA can be expected to find their way into Europe. IBM will announce a successor to the 3750, probably to be marketed on a world wide basis. The market for computerised branch exchanges will grow, as more and more electromechanical switches reach the end of their life. But the market may well become more competitive too, as newcomers pick up the franchise for American products. The suppliers with existing products will continue to have an advantage, through the possession of PTT approvals for their offerings.

4 Word processing

The economics of word processing are still, except in those countries with the highest labour costs, marginal. Although the cost of word processing equipment is modest in relation to most computer-driven systems, it remains high enough at present to deter many potential customers. At present cost levels an adequate return on investment can only be projected at a level of utilisation which in most offices is too intensive to be realistic (see Report Series No 2, Sections VI and VII). At the same time it is important to recognise that word processing – at least in its communicating mode – represents the tactical foothills of the systems of the future. The combination of the word processor and the data terminal is a natural move towards the multi-function workstation.

There are of course situations in which word processing is already economically justifiable, where the work mix is to some extent untypical. Such a work mix may contain an unusual

amount of repetitive draft typing or a large number of standard personalised letters. But even in cases where there is at present no sound economic reason for launching into word processing, there are still two good reasons for embarking upon an experimental installation. The first is the role of communicating word processors as a path towards the future, mentioned above. The second is connected with cost trends. Sooner or later, as hardware costs decline and labour costs rise, word processing will become economic in its own right. The companies who will benefit at that stage will be those who have acquired some experience in pilot installations, who have advanced some way along the learning curve in resolving the organisational and human problems that word processing poses.

5 Investment planning

The prudent manager will also take thought about the different investment cycles which prevail within the three areas of computing, telecommunications and office automation. First the periods of amortisation common in the three areas differ widely. Computers are currently written off in many firms over 5 to 7 years. Private telephone exchanges commonly have a much longer life expectancy, sometimes as high as 20 years. This discrepancy may pose serious problems, since worthwhile projects may be hampered if old-fashioned switches have too long an unexpired life. It is likely that the accelerating pace of change in the technology of telecommunications will encourage a progressive reduction in the life expectancy of private exchanges, until they eventually harmonise.

The second problem posed by the long amortisation period of exchanges is discrepancies between sites. When one office's switch is due for replacement, another's still has five years to run. Thus a uniform level of technology is hard to achieve. In one sense this problem is guaranteed of solution. Since the PTT ensures that all switches conform to the public network's requirements, they can all talk to each other. But the problem remains unsolved in the sense that features provided at one site — both system features and user features — may not be provided at another. Moreover IBM is currently beginning, with a major customer from the oil industry, to link 3750s across the public switched network. This will give telephone users between sites some of the same facilities they enjoy within a site. Clearly any major discrepancy in investment cycles would destroy such possibilities.

For all these reasons it is highly desirable to move towards harmonisation of the investment cycles at different sites. The only company known to have resolved this problem totally is one which rose from the ashes of a bankrupt predecessor. All its capital debts had been liquidated and later a new balance sheet drawn up. All its communication investment dated from re-incorporation. This is too drastic a solution to be generally applicable.

6 Relations with the PTT

Few companies exploit to the full the readiness of the PTTs to assist with the planning of telecommunication systems. All too often the first the local PTT knows of a scheme is when it receives a detailed plan with specific requests for service. One of the key criteria for the performance of any telecommunications authority, as a frugal employer of public capital, is to keep to a minimum the unused spare capacity of the network. This requirement reduces the ability of any PTT to respond to unforeseen requirements. In general it is prudent to maintain regular contact with the PTT and to seek its involvement in particular telecommunications plans.

7 The Management Services function

Convergence is drawing the computer suppliers, the communications companies and office equipment firms into the same market. But by the same token it also poses new problems for the user of systems. One of these concerns the organisation of the management services function. In most large companies, management services already embraces computer systems, organisation and methods and operational research or management science. To provide unified policy-making in the three areas covered by convergence, however, a much broader spectrum of control is required. In many companies this does not yet exist. In many cases voice communication is a separate function, outside the control or even the

influence of management services. Office equipment is even more usually under separate control. Some management services directors thus do not control developments for example in word processing within their companies.

Although it is always risky to generalise about organisational matters, the separation of the control of computers, communications and office equipment is very likely to lead to problems in the future. First of all, the three separate functions will almost certainly have to negotiate with the same suppliers and will suffer a needless loss of purchasing leverage by pursuing disparate lines of argument. (Even when list prices are not negotiable, levels of after-sales support usually are). Secondly and even more importantly, the broad conceptual view of the possibilities offered by convergence is bound to be dissipated if the expertise is fragmented and uncoordinated. Thus although the political and organisational problems of achieving unified control of these three areas will in many cases be most daunting, it is a prerequisite to progress.

8 Computer management

The theory and practice of computer management were formed in an era when the central machine was the dominant capital asset. For this reason both theory and practice are based on the tacit aim of getting high utilisation of the machine. There are innumerable pieces of evidence for this view. For example how many companies are free from the complaint that programmers cannot test their programs because of a shortage of machine time? Yet thus we assert implicitly that computer time is more valuable than man or woman time. As hardware costs decline and people costs grow, the equations of the past lose their validity. The prudent manager will monitor this trend and radically reappraise his computer management rulebook.

9 System development

As already indicated, software development methods are already being studied and revised in attempts to secure quicker and less labour intensive systems. At the same time, it will be essential to avoid the excessive complexities of the past: otherwise the convergence of technologies will simply have spawned a monster. There is a target for the new system development methods which goes beyond the mere avoidance of wasted effort or uncontrolled complication in system development. It is one which lies at the heart of the technical difficulties attached to convergence.

Given the current state of the art, it is quite possible for a user to extract from a data file some sales statistics using a data terminal. It is also possible for him to use a text editing word processor to compile a letter to a customer. But what if he wants to incorporate the data in the letter? In most installations today the only way he can achieve this modest goal is to print out the sales figures on his data terminal, walk across to the word processor and type them in again.

Data processing applications have evolved, in other words, quite separately from other information systems such as text, voice and graphics. There is (as far as we are aware) no operating system in existence which attempts to unify them, to permit the user to migrate from one application to another, and to take with him the information he has gathered en route. It seems highly improbable that users will tolerate this limitation forever. Yet because of the complex operating systems in which data processing applications are currently embedded, it will take a massive effort to provide inter-application linkage. Here is an important and basic task for the future. It will be interesting to see who first claims to have solved it.

10 The total cost of information

There are statistics aplenty to prove the growth of the information sector since the end of the second world war. There have been massive migrations from the agricultural and manufacturing sectors into information handling (see Report Series No 4). Such analyses are usually based upon the government labour statistics published in various countries. What

they do not show is the impact of this trend upon the individual enterprise. Here there is an almost total paucity of information handling in a given company? It is highly probable in most firms that no one will know or be able to make an informed guess.

Of course there are some cost elements which for practical reasons are virtually impossible to assess. How would an oil company measure the time spent by forecourt attendants recording sales of petrol?

Nevertheless a good deal of light can be thrown upon the total cost of information. Computer costs are generally fairly easily identifiable, though the position is somewhat complicated by the modern trends: data entry tends to be handed back to the end-user and small computers tend to glide unseen below the minimum authorisation threshold. Communication costs, especially telephone costs, tend to be buried in a hundred budgets: but all that is required to disinter them is spadework. One of the traditional strengths of the traditional office manager — whatever his weaknesses — is the maintenance of inventories. At least as far as these three cost centres are concerned, therefore, it is in most firms arduous but not impossible to arrive at a fair degree of certainty.

Why bother? What aim will be furthered by compiling this very considerable volume of data, or arranging for it to be gathered systematically? There are two main reasons, one objective and one subjective. First, the design of modern information systems (particularly in the era of distributed processing) involves important trade-offs between the cost of intelligence (processing power) and the cost of communication. Unless these relative costs are known, and known more readily and reliably than a periodic sample can achieve, the trade-offs cannot be intelligently made. The lack of such information causes system designers to fly blind in a crucial area of judgment. Secondly, it is a regular complaint of management services directors that their efforts are not given the time and attention they deserve by top management. There is some justice in this complaint but at least part of the explanation for top management's diffidence lies in the way systems are presented. Top managers think mostly in money terms. Computer departments consume on average around 1½ to 2 per cent of total corporate expense. This is too low a figure to interest most boards of directors. In those few cases, however, where an attempt has been made to measure the *total* cost of information handling, the results indicate that the figure is closer to 15 or even 20 per cent of total cost. This level of expenditure is far more likely to interest top management as an area of potential improvement.

C The Skills Vacuum

The design and application of computer systems and telecommunication networks are independently difficult areas. If the major thesis of this report is correct — that the convergence of technologies is creating a single discipline of information system design — then the skills required for the construction of adequate systems will be further compounded over the years ahead.

A particular case of this phenomenon is the management services director whose portfolio already includes communications. In most cases his background and training will lie in the area of computer system design. When his staff present him with a computer system proposal, his own accumulated experience serves to give him a mental checklist of possible weaknesses. Are the estimates for maintenance satisfactory? Is the planning and development cycle realistic? Are manpower plans convincing? Yet in relation to a plan for a communications network, his experience is by no means as profound. How can he satisfy himself that the same weaknesses he is accustomed to finding and remedying in systems proposals do not pass by unchallenged in this less familiar field?

At levels below the management services director there is also a need to retrain staff (project leaders, analysts and programmers) to approach their jobs in a different way. In the past systems analysts designed computer procedures largely to fit the computer. In the future,

when it becomes possible to place intelligence virtually without restriction, it will be possible to design systems to suit the way people work best. Many systems analysts who have learned the lessons of computer-centred system design will need to be retrained to appreciate fully the new opportunities that convergence creates.

There is a vacuum in many organisations where some very important skills should be. The areas include word processing, network design and the evaluation of computerised branch exchanges. It is vitally important that these deficiencies should be identified by means of a skills audit and remedied wherever possible by training and development.

A The US Experience

There is one important constraint upon the marriage of computing and telecommunications to which only passing reference has so far been made. That constraint is the influence, always significant and sometimes decisive, of the regulatory authorities in the various countries. In the USA the main regulatory body is the Federal Communications Commission. In Europe regulation is the preserve of Governments.

For some time now the Federal Communications Commission (FCC) has been trying to defend the indefensible, to buttress a distinction between computing and communications that is increasingly hard to define. Recent events illustrate this fact dramatically. The USA's monopoly communications company, AT&T, has long cherished the aim of offering both a data communications and a data processing service. To achieve this aim it must convince the FCC that such a service does not conflict with the 'maximum separation' ruling – separation that is between the common carrier and the end use of the data – or alternatively persuade it to change that ruling. The responses of the various interested parties are eminently predictable. IBM stated that, "If that were to happen, a large segment of potential data processing applications would be relegated to monopoly carriers." In reply AT&T stated that, "It would be a blow if the Bell System couldn't offer its users a complete data communication package."

On the face of it the FCC regulation is pretty clear. It states quite categorically that telecommunications carriers are not permitted to offer data processing services. The ambiguity, however, lies in the terms employed: and gives us a further illustration of the reality of the convergence of technologies. The FCC was pressed for a definition of data processing, so as to make clear to the common carriers just what they were *not* permitted to offer. The following definition was forthcoming: "Data processing is the electronically automated processing of information where the output information constitutes a programmed response to input information." It was quickly pointed out to the FCC that this definition could equally well be applied to the telephone network itself – a result they could hardly have intended.

AT&T of course wish to eradicate as far as possible the firm boundaries between communications and computing. Having seen computer companies enter the fields of private switching, and seeing one of them entering satellite communication, AT&T's reaction is scarcely surprising. Nor should we expect its efforts to enter data processing to diminish.

B The European Position

In Europe the regulatory position is very different – in some ways more restrictive and in others less. All companies, whatever their traditional industry, stand equally in relation to the PTTs when seeking approval for devices to be connected to the public network. Moreover any company that wishes to do so can operate a computing service over the public network.

The rules governing connection to the network are, however, more complicated, more time-consuming and more costly for the would-be supplier than in the USA.

Perhaps the biggest weakness in the European position stems from the fact that all its telecommunications authorities are not just monopolies but also public monopolies. This fact

gives the PTTs certain strengths, particularly in areas such as public accountability (AT&T in contrast is rather secretive) and in the maintenance of services which are socially desirable. But it also creates some strategic weaknesses.

The United Kingdom Post Office, to take one example, is charged with certain responsibilities under the Post Office Act, 1969. There are certain services it must provide (e.g. telephones, letters) and certain services that it may provide if it wishes. In some of the main areas of its business it has what is termed in the Act 'exclusive privilege', i.e. monopoly rights. The vital part of the Act, however, is that which obliges the Post Office to relate its services to the social, commercial and industrial *needs* of its market. Now this obligation — which has been interpreted fairly literally in the past — means that the Post Office should not provide services for needs it thinks may arise, or could be caused to arise by market stimulation. Taken very literally, it would probably have led to the strangulation at birth of services such as Viewdata, or indeed of any data communication services whatsoever.

Of late there is evidence that the Post Office (and other PTTs) is interpreting its brief in a slightly less literal-minded way. The Act for example also enshrines the principle that the user of a service should pay the full cost of the service, without any use of marginal pricing to smooth the load of demand. Nevertheless marginal pricing is used to attract off-peak telephone calls. But even if the Post Office were to strain its brief to the limit, it is doubtful whether it could meet the needs of the future in every respect. It is worth explaining why.

There is a considerable degree of doubt about the precise ways in which any particular technical innovation can best be used in future communications systems. Everyone agrees, for instance, that there is great potential in optical fibre links and in satellites. But how will these inventions be used? No one can be sure. Nevertheless the development cycle for such services is very long, and the investment cycle for firms who wish to use such services is also long. Thus the shortest route to successful implementation is to allow a variety of fairly risky experiments to take place, the risk being shared by the supplier and his customers according to their commercial judgment. In this way the natural selection of the market feeds the winners and starves the losers.

Because a public monopoly by its very nature cannot indulge in risky experiments — rightly — it has a natural tendency to select a fairly conservative technology and to commit its resources only as far ahead as it can reasonably assess future prospects. This philosophy is excellent for the application of technology, but not well suited to its creation. It is for this reason that informed critics ask a difficult question: how will Europe infuse its developments in telecommunications with the same dynamic which competition creates in the USA? And how can it do so without impairing the ability of the PTTs to continue doing what they do in general very well — the management of national and international communications networks?

C Is Europe At Risk?

The uncertainty about the source of Europe's drive to apply the new technologies stemming from convergence also prompts a further question. Such technologies are already being applied faster in certain other countries such as the USA, Canada and Japan. How serious will it be for Europe if this technology gap persists or even widens?

A good system of public and private communications, catering for voice, data, text and image processing, may be as important in the future to the wealth of a nation as a good system of surface and air transport is today. As with any part of the economic infrastructure, it is virtually impossible to quantify the benefits deriving from a good system of this type or the penalties inflicted by a bad. But expert testimony certainly suggests that the information handling infrastructure will be at least as important as any other.

Uniquely qualified to judge, perhaps, is James Martin. Mr. Martin is a Briton resident in the United States, a world-famous lecturer on computers and communications and the author of around a dozen standard works on those subjects. He is also a full time research worker for

IBM and so is aware of much of the development work going on within that company. Mr. Martin has observed at first hand the innovative experiments that have taken place in the USA since the major policy changes of the late 1960s and, though far from an uncritical admirer of them all, has no doubt that on balance many worthwhile innovations have reached the market much earlier than would otherwise have happened. He has made no secret of his concern that at a time when the USA, Canada and Japan will have first rate communication systems for data, text, voice and graphics traffic, Europe will be limping behind still searching for the right innovative philosophy. Mr. Martin's judgment, as one still deeply concerned for the continent of his birth, is that Europe is very definitely at risk – technically, industrially, commercially and socially.

It would be wrong to end this section of the report without emphasising that these concerns are not to be construed as hostile criticisms of the PTTs of Europe. Any impartial assessment would be bound to conclude that the defects in Europe's armoury cited above are not the fault of the PTTs. They are weaknesses in the policies of the countries concerned, and trouble the PTTs perhaps as much as they do Mr. Martin.

V. THE PRUDENT MANAGER'S GUIDE

A Introduction

The world of computers is faddy and riddled with unintelligible jargon. Every few years some new fashion seems to catch the fancy of the computer community, and for a time everything revolves around this fashionable notion. Is there any evidence to suggest that the convergence of technologies is more than just the latest in a long and fundamentally trivial list of catch-phrases?

We hope that the evidence assembled in this report presents a convincing overall picture of the changes occurring in three related industries. There is no doubt at all about the irruption of silicon technology into the communications and office products industries. There is no doubt at all about the seriousness of the challenge posed by IBM in the areas of private switching and satellite communications. It is equally certain that competing products in the workstation market will come from all three industries. And finally there is no doubt that the brains of the regulatory authorities in the USA are being fully, indeed perhaps frenetically, stretched to try to invent any meaningful distinction between the business of data processing and the business of communications.

All the fashionable notions of the past have one thing in common. They have had virtually no impact on the world outside the tight echelons of the computer community. Convergence in contrast is already producing a reaction of a much more widespread nature. For this reason we believe it to be an important and enduring phenomenon rather than a transient catchphrase.

B Guidelines

In this section of the report we abstract specific recommendations for management action from the policy areas described in Section III B. The aim is to produce an instantly intelligible checklist of policy questions that need to be systematically reviewed. The prudent manager keeping vigilant watch in these areas should acquire a better understanding of his company's position in response to convergence. The list is a prescription, in short, for wise virgins.

1 **Network design**
Train yourself and your staff to understand the realities of network design, taking a jaundiced look at the features offered by suppliers. The question is not whether they exist but whether your managers will use them.

2 **Multi-function workstations**
Watch out for these important new products. Try to time the introduction of new user facilities over the next few years in the light of their certain impending arrival.

3 **Switching**
This is a key area because it lies at the heart of reduced office costs: see Section III B for the logic of this important argument. Look out for the addition of data switching facilities to existing voice switches, and for IBM's new product. Keep your amortisation periods as short as possible.

4 Word processing
Even if word processing is not yet economic for your organisation, start up a small pilot installation. The experience will serve you in good stead when the inevitable economic crossover point comes.

5 Investment planning
Try as hard as you can to align your replacement dates for larger network components, including switches and computers.

Despite the undoubted difficulties of so doing, there are considerable benefits. An ambitious and worthwhile scheme can be financially undermined by the unexpired capital life of one obsolete switch.

7 The Management Services function
At some future point you may find it necessary to reorganise management services to place computers, telecommunications and office equipment under unified control. At present it is certainly worthwhile to check on the liaison of these three functions. A common fault is to have the point at which their lines of responsibility meet too far up the organisation, so that no practical means of resolving differences exists. To avoid fragmented systems and wasteful buying these three functions must be carefully coordinated.

8 Computer management
Your manuals on the management of computer projects may unconsciously enshrine the belief that the computer is the centre of every system. It is worth taking a hard look at these procedures. They may well be quite inappropriate to the equipment you are actually buying.

9 System development
Watch out for a major emphasis on better value for money in system development. It is the natural priority in the era of cheap hardware. Watch out too for the first supplier who can link applications (e.g. data, voice and text processing). He will be worth a visit.

10 The total cost of information
Set in motion an exercise to measure what you actually spend as a corporation on computing, communications and office automation. It will take a great deal of effort to get useful figures. Your technical staff will tell you it can't be done, or is a waste of effort. But without this information you cannot intelligently trade-off computing costs against telecommunications costs.

C Conclusion

This report is intended to provoke as many questions as it answers. It provides a framework for debate within the Foundation which should lead to a considerable number of topics for specific research, over and above those already completed or in hand.

Abstract

Report Series No 5

The Convergence of Technologies

by David Butler February 1978

The purpose of this report is to alert managers to a fundamental change in the way that information systems are conceived, designed and used, as a result of the so called 'convergence of technologies'.

The main components of a present-day business information system — apart from the human and organisational resources contained therein — are the products of three separate and previously non-competing industries. The most ubiquitous element is the ordinary telephone, providing both internal voice communication and external links via private and public exchanges. The second element is computers and (increasingly) microprocessors incorporated in other devices. And the third is the agglomeration of devices known as office machines — including typewriters, copiers, printers, microfilm, and paper storage systems. Convergence is the process by which these three industries are coming to depend upon a single technology. They are becoming, to all intents and purposes, *three branches of a single industry.*

This report presents a convincing overall picture of the changes which lie at the root of this movement. There is no doubt at all about the irruption of silicon technology into the communications and office products industries. There is no doubt at all about the seriousness of the challenge posed by IBM in the areas of private switching and satellite communications. And it is equally certain that competing products in the workstation market will come from all three industries.

The world of computers is faddy and riddled with unintelligible jargon. Every few years some new fashion seems to catch the fancy of the computer community, and for a time everything revolves around this notion. But they have had one thing in common: they have had virtually no impact on the world outside the tight echelons of the computer community. Convergence in contrast is already producing a reaction of a much more widespread nature. For this reason it is an important and enduring phenomenon rather than just a transient catchphrase.

This report describes the impact of convergence on suppliers and on users, and examines the US experience and the position of Europe. Finally it abstracts specific recommendations for management action in order to produce an instantly intelligible checklist of policy questions that need to be systematically reviewed. The report is intended to be read by managers of departments which *use* systems as well as by the managers responsible for *providing* systems — and by line as well as staff.

The Butler Cox Foundation

The Butler Cox Foundation is a research group which examines major developments in its field – computers, telecommunications, and office automation – on behalf of subscribing members. It provides a set of 'eyes and ears' on the world for the systems departments of some of Europe's largest concerns.

The Foundation collects its information in Europe and the US, where it has offices through its associated company. It transmits its findings to members in three main ways.

- as regular *written reports,* giving detailed findings and substantiating evidence.
- through *management conferences,* stressing the policy implications of the subjects studied for management services directors and their senior colleagues.
- through *professional and technical seminars,* where the members' own specialist managers and technicians can meet with the Foundation research teams to review their findings in depth.

The Foundation is controlled by a Management Board upon which the members are represented. Its responsibilities include the selection of topics for research, and approval of the Foundation's annual report and accounts, showing how the subscribed research funds have been employed.

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