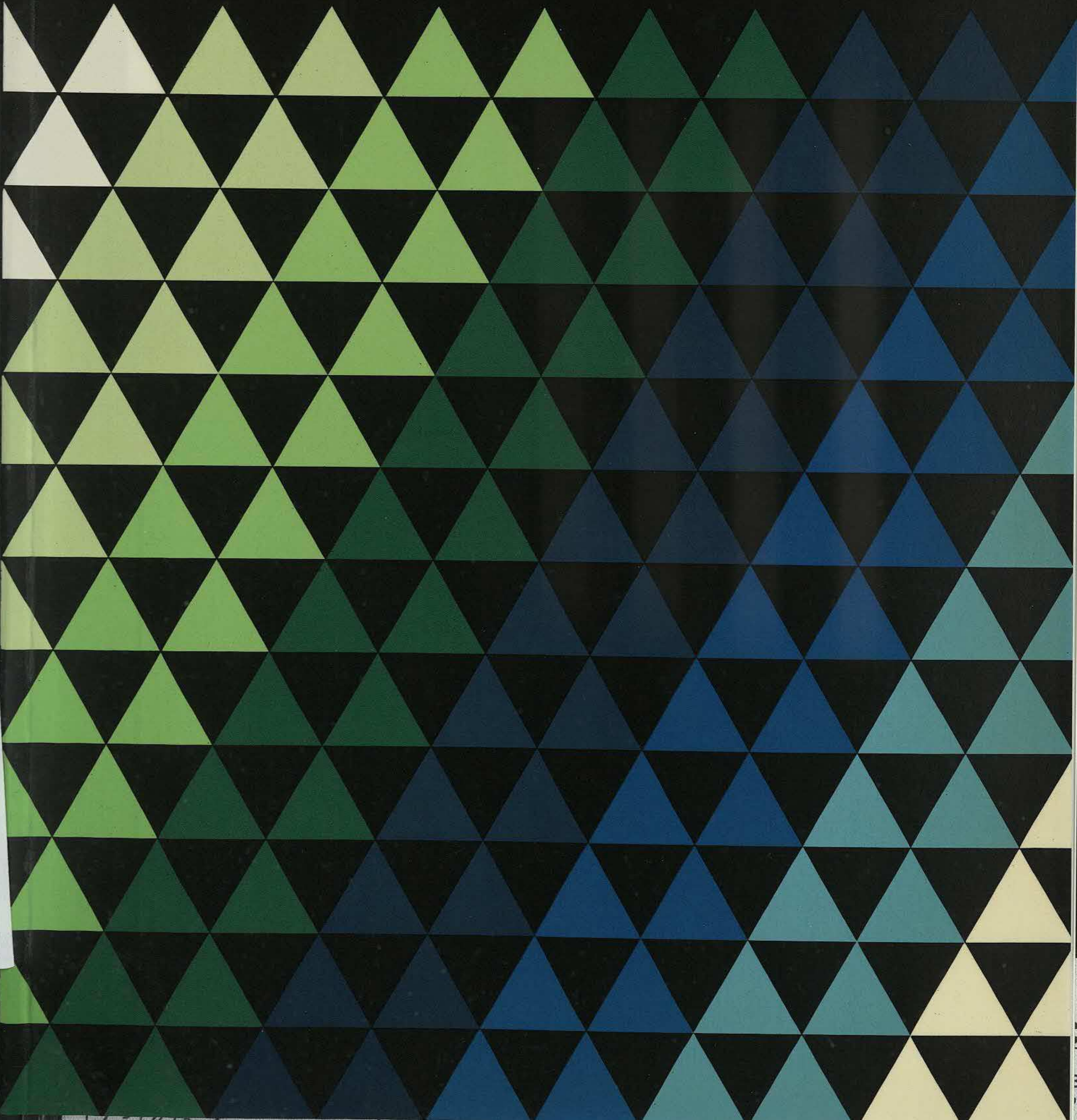
Using Information Technology to Improve Decision Making

BUTLER COX
FOUNDATION

Research Report 53, November 1986



BUTLER COX
FOUNDATION

Using Information Technology to Improve Decision Making

Research Report 53, November 1986

Butler Cox & Partners Limited

LONDON
AMSTERDAM NEW YORK PARIS

Published by Butler Cox & Partners Limited
Butler Cox House
12 Bloomsbury Square
London WC1A 2LL
England

Availability of reports and report summaries
Foundation reports are available only to members of the Butler Cox Foundation. Members receive three copies of each report upon publication; additional copies and copies of earlier reports may be purchased from Butler Cox. Reprints of the summary of research findings for each report are available free of charge.

Photoset and printed in Great Britain by Flexiprint Ltd., Lancing, Sussex.

BUTLER COX
FOUNDATION

Using Information Technology to Improve Decision Making

Research Report 53, November 1986

Contents

BUTLER COX FOUNDATION

BUTLER COX
FOUNDATION

Using Information Technology to Improve Decision Making

Research Report 53, November 1986
Summary of research findings

The impact of information technology on decision making at senior and board levels in most companies has been very limited, and any impact that has been felt has been indirect. It has changed the method of work of those who report to the board, but not of the board itself. Moreover, the efforts of the systems department to sell information systems to top decision makers have, in most enterprises, been half-hearted and ineffective.

Information technology seems to have the best chance of helping the decision maker at senior and board level when the technological needs are considered after the business and organisational needs. This in turn implies a need for the systems director to work more closely with the finance and corporate planning functions, or to run the risk that they may usurp parts of the systems function.

We found some evidence that managers are not averse to using a keyboard, provided they can see the benefit clearly enough. But other input media such as light pens, touch-sensitive screens, and infrared remote control units are regarded by managers as gimmicks. Indeed, top managers seem to resist the 'technology-transfer' process. They are more willing to learn from outsiders than from their own staff. External staff may be better placed to teach the appropriate skills and the astute systems director therefore exploits external resources for his own purposes.

Colour graphics are a major asset in interesting top managers in information technology. But graphics must be used well (see our guidance in Foundation Report 40 on presenting information to managers), and the creation of a logical visual standard is crucial. For example, if red is used to indicate good performance in one graph but bad performance in another, the top manager loses interest.

Expert systems are a major opportunity for the future. Technology and understanding have advanced since our earlier and somewhat cautious report on this subject. American scholars believe that all major companies should now be involved with expert systems. We agree. A forthcoming Foundation report, to be published in 1987, will examine the business applications of expert systems.

Our assessment of the various technologies that we have considered is set out below:

- *Videoconferencing* will grow slowly but will not become vitally important to many companies. The most likely successful users are companies that have widespread project teams working on common projects, particularly high-value capital projects such as the design of motor cars or aircraft.
- *Audioconferencing* is difficult for users to accept happily, particularly if three or more people are involved. The resistance of users to this 'uncongenial' technology may rest upon psychological factors not fully understood, and not fully defused by the use of add-ons such as freeze-frame television or the ability to exchange documents by facsimile.
- *Boardroom graphics* can be applied with great effect when the necessary analysis of the board's real requirements has been conducted. The effort and cost of amassing the necessary backlog of data will deter many organisations, but the benefits for the imaginative user can be great.
- *Computer conferencing* will be used by geographically dispersed project or research teams for whom the cost of full-video systems cannot be justified.
- *Thinking aids* will be used by a minority of people with a highly systematic approach to intellectual problems.
- *General-purpose decision-support systems* able to answer ad hoc queries from a variety of users require substantial databases and an easy-to-use query language. They require substantial investment and should not be embarked on unless they will be an indispensable tool for the decision maker.

- *Expert systems* are now emerging from the research laboratory and the hyper-specialised arena to play an important part in the life of the enterprise. Those who took the advice we gave in 1983, that expert systems could be largely ignored for three years, should now take our current advice: if they are not yet involved in expert systems, now is the time to start.

RESEARCH TEAM

The research for this report was conducted by David Butler, Chairman of Butler Cox; Neil Farmer, a senior consultant with Butler Cox in London; David Flint, the Foundation's Research Manager; and John Kinnear, the International Director of the Foundation. The research consisted mainly of face-to-face interviews with senior managers from large organisations to find out how they were using information technology in decision-making situations. In all, 35 organisations from five countries (Australia, France, Italy, the United Kingdom, and the United States) were examined.

Chapter 1

The role of information technology in management decision making

As long ago as 1969, Peter Drucker published one of the most stimulating management books ever written. It was entitled *The Age of Discontinuity*. In it, Drucker drew a sharp contrast between the stable, slow-changing world of the past and a world in which financial, economic, political, technological, and social change was rapid and fundamental. He highlighted both the high-technology industries of the future and the new breed of managers (he called them the New Entrepreneurs) who would be required to run them. "Businessmen will have to learn," wrote Drucker, "to build and manage an innovative organisation . . . a human group which is capable of anticipating the new, capable of converting its vision into technology, products and processes, and willing and able to accept the new."

If Drucker's vision is to become reality, information is the key resource, and information systems are the enabling tool. The purpose of this report is to assess to what extent and in what ways the information systems of 1986 measure up to the challenge issued by Drucker in 1969. Are systems genuinely helpful to managers in decision making? Or are they still (as they were in 1969) concerned mainly with low-level record keeping, remote from the real processes of decision and action?

The question is hardly new. Even the lowest-level data processing and communications systems can be said to have some role in improving decision making. Otherwise, what would be the point of having them? There are countless computer systems that now make repetitive operational decisions once made by people. Most such systems operate at a low level within organisations — hardly the kind of management support Drucker had in mind. In recent years, however, there has been more interest in applying information technology to higher-level decisions and to its use by middle and senior management. The question is whether this interest has produced useful results.

Systems used in decision-making situations can be divided into those that:

— Make and implement decisions automatically.

— Suggest decisions for verification and approval.

— Help decision makers to explore different decisions.

Systems that make decisions automatically are not new. Stock-control systems are an early example of such a computer application. Aircraft landing systems are another. In both of these examples the level of the individual decisions made is low but the effect of errors in the system rules may be very significant. Recently, it has become possible to construct systems that make higher-level (and higher-value) decisions, as hardware becomes cheaper, as the necessary data is more often already stored somewhere in a system, and as managers become more used to computers. For example, at the 1985 International Conference of the Butler Cox Foundation, Bill Cook of Morgan Stanley described (in a paper that has now been published for Foundation members) a portfolio management system that was making better buying and selling decisions than a human dealer. The system required low-cost, high-capacity computers, up-to-date electronic stock data, and computer-literate managers in positions of influence.

Many of the systems that now make decisions automatically were first installed as decision-suggesting systems. Thus, early stock control systems would produce lists of order suggestions, for action or amendment by human operators. This approach was taken mainly as a means of proving the system, but also because there was often insufficient processing power or data for the computer to make all the reordering decisions automatically. This process still continues — the portfolio management system mentioned above was installed in the same way.

There is now a new class of system that suggests decisions — expert systems. An expert system attempts to suggest a likely solution or decision in cases where a complete set of rules or data does not exist. In an expert system a set of rules is established, based on the experience of experts. The rules do not have to be exact — in principle, expert systems can handle imprecise rules such as 'A is usually less than B' with which traditional data processing cannot cope. In some respects, expert systems are similar to some operational research systems in that they minimise the chance of making a bad decision or maximise the chance of making a good decision. As such, they are used at present as advisory systems — making the knowledge of experts more widely available so that it can be used by less experienced people. However, some medical expert systems now provide a better diagnosis in a limited field than most doctors. Expert systems will initially provide assistance for professional workers but may increasingly take over their role (or reduce their ranks), as computers have already done for clerical workers.

In the past, there have been many attempts to use computer technology as an aid to management decision making, but these have, at best, met with partial success. In the late 1960s, many organisations invested considerable sums of money on so-called MIS — management information systems. The computer pioneers dreamt of integrated databases containing comprehensive information about their organisation and the world in which it operated. They talked of managers sitting at terminals asking the computer 'what-if' questions while the computer instantly modelled the answer. All these projects ended in failure.

Nowadays, sane people no longer talk of MIS, but of decision-support systems. We have some difficulty with this terminology, however. The original definition of a decision-support system by Peter Keen and Michael Scott Morton (see reference 1) is lucid and sensible. According to them, a decision-support system uses a computer to:

- Assist managers in their decision processes in semistructured tasks.
- Support, rather than replace, managerial judgement.
- Improve the effectiveness of decision making rather than its efficiency.

Regrettably, not all the followers of Keen and Scott Morton share their enthusiasm for clarity. Many systems managers now speak of decision-support systems as if they embraced virtually any computer application outside the field of classical, large-system data processing. In this respect, they are in danger of following in the footsteps of the MIS fanatics of the 1960s.

When considering how best to apply computer technology to management decision making, the systems manager of the 1980s has a huge advantage over his counterpart of the 1960s. He has at his disposal much more effective system building tools and a much wider range of captive data. He may also use, if appropriate, a far wider range of proprietary databases to provide external data on prices, products, currencies, or commodities. Yet he still faces some of the same difficulties.

It has been argued that historical facts are of very little use in strategic decision making. All decisions are about the future, and there are no data about the future. Computer databases are about the past. Although models can be used to suggest the future, managers have to decide whether the past is a reliable guide and whether the model is sufficiently realistic. The further into the future we look, the less likely it is that the past is relevant. A speaker at a Butler Cox Study Tour meeting described such a management system as "trying to steer a ship by watching its wake". Moreover, computers cannot assess uncertainty about future events or what trade-offs should be made among conflicting objectives. And, if Drucker is right about the future, uncertainty is itself the only certainty.

It would, however, be misleading to suggest that databases have no role in managerial decision making. Most decisions are not about the long-term future, but about the immediate future. Managers require information about the current situation before they can decide what to do about it. This is particularly true of new business ventures. Managers need to monitor such ventures closely and take corrective action quickly if it is necessary. In Chapter 2 of this report (on page 5) we describe an example of a system designed to monitor such activities.

At the 1985 International Conference of the Butler Cox Foundation, Professor Daniel Isenberg argued that in the past we have tackled management decision making as if it were a rational process, whereas in practice the process is full of uncertainties that militate against a purely rational approach. These uncertainties (as Drucker suggested) embrace political, technological, financial, and organisational issues. They give rise to problems that are ill-structured, and it is the ill-structured problems that cannot be pushed down the line and that cannot easily be systematised. Such problems have the following characteristics:

- 'Experts' disagree on the definition of the problem.
- There are multiple, interrelated symptoms.
- There is imprecise, unreliable information about the symptoms.

One difficulty with the concept of 'decision making' is that, in practice, managers are not faced with isolated choices. They have a portfolio of problems, issues, and opportunities in which:

- Many problems and issues exist simultaneously.

– The problems and issues compete for some part of the manager's immediate attention.

– The issues are interrelated.

Professor Isenberg suggested the use of the term 'problem management' (as an alternative to either decision making or problem solving) to describe the situation, seeking thus to convey the message that problems or issues are often not solved in any definitive way. Rather, the manager has a 'problem network' that he manages in order to allow him to make appropriate moves as opportunities arise.

The main emphasis of information technology to date has been to support better (that is, more rational) decision making. In practice — as Isenberg demonstrates — many decisions, in particular those taken by more senior managers, cannot be made on the basis of a rational set of rules. And if this has always been true, how much more true is it in Drucker's Age of Discontinuity.

How then can information technology help? In our view there are two main ways. The first is in assisting groups of people to reach a collective decision. Usually, where a decision has to be made by a group of people, a meeting of those concerned is arranged, the issue discussed, and a decision made. Today, many organisations have installed technology in meeting rooms to help participants to understand better the issues being discussed. Others have introduced various types of teleconferencing technology to reduce the need for face-to-face meetings. In Chapters 2 and 3 we discuss the experience in each of these areas.

The second way of assisting senior managers in decision making is to provide them with access to data and computing facilities. Nowadays, more managers and professional workers have access to computer terminals and personal computers. There is an increasingly wide range of data available via internal networks and public online services. Moreover, new computing techniques are emerging, and the improving cost/performance ratio of equipment and software is making older techniques more economic. The ways in which computers can provide direct support for decision makers are discussed in Chapter 4.

This report focuses on the use of information technology to improve management decision making. During our research, however, we developed a framework for determining when the use of information technology is suitable for automating the decision-making process, for suggesting decisions, for providing information and information processing aids to decision makers, and for helping a group of decision makers to communicate with each other. The framework, which is described in the Appendix, consists of a set of preconditions and indicators that are examined to assess which type of system might be appropriate, given the characteristics of a particular decision.

But our yardstick for assessing suitability of a particular type of system to management decision making is a simple one: to what extent might it prove useful to Drucker's New Entrepreneur?

Chapter 2

Helping groups of people to make decisions

How do managers make decisions? All the many studies of how executives spend their time are unanimous on the point that meetings are a common decision-making forum — casual meetings of two or three people or larger and more ordered assemblies. Our research for this report uncovered a deep vein of scepticism about the usefulness of meetings. Often they lead to ambiguous, inconclusive, or even meaningless decisions.

We found many reasons for this scepticism. Meetings may be ineffectively chaired. The debate may be monopolised by one or two forceful personalities. Insufficient preparation may have taken place, so that the issues are not clear and the likely consequences of a given decision are not properly understood. Sometimes the decision limits of the participants are not clearly defined. We know of one company where every manager's decision limits are defined, and where it is forbidden for a meeting to end without a decision being taken. If the debate rises above a manager's decision threshold he must contact his superior to get a ruling. The one crime for which there is no forgiveness in this company is to be unavailable for a telephone call. This regime — more like a military command and control system than a conventional management structure — seems at first sight excessively rigid. In terms of the company's profit performance, however, it works.

It is clear that many (perhaps most) meeting problems are rooted in the organisation, its purposefulness, and the leadership qualities of its upper echelons. Information systems are unlikely to provide a complete answer to these problems. Yet they can help in several ways, making effective meetings more effective and highlighting the shortcomings of the others.

We have identified two main ways in which information systems can be used to help groups of senior staff to make decisions — boardroom systems and decision conferencing.

BOARDROOM SYSTEMS

Boardroom information systems bring wall-sized displays, with an emphasis on colour and graphics, into meeting rooms (sometimes known as 'war rooms'). Participants use the displays, which they may control for themselves, for briefing and decision support. In many companies such systems are first installed (as their name implies) in the boardroom; in others they are installed in executive meeting rooms and used for a variety of meetings. The technology installed in meeting rooms is often used for training and sales purposes, and often a single room will be used for multiple purposes.

Delegates on the Foundation's Study Tour of Japan in 1986 visited the decision room in Toshiba's 'Intelligent Building', the firm's headquarters in Tokyo. The facilities there allowed charts and information generated on the departmental computers located throughout the building to be displayed on giant screens. The same screens could be used to display graphics generated within the room, still pictures of slides or charts brought to the room, live television pictures, and the output from commercially available information-retrieval services.

The idea of an operations room or nerve centre where leaders can mastermind activities is not new. The British cabinet war rooms in World War II were equipped with this in mind, and some businesses have built their own equivalents of war rooms in the intervening years. This development has come about because of the wide range of services that can be provided at a relatively modest cost and because of the increased acceptability of the technology at senior levels in some organisations. During the last few years we believe that more than 100 such systems have been built in the United States, and many more organisations are actively considering them. The pioneer in the United States was Northwest Industries, though its system has now fallen into disuse. In the United Kingdom, several larger companies (including British Oxygen, BP, British Telecom, ICI — of whom more below — ICL, the Imperial Group, Shell, Exco, and Redland) have installed, or are considering, boardroom systems. Overall, we estimate that there are more than 50 boardroom systems installed in Europe.

ICI is a particularly interesting example, because the board has been enthusiastic about the system, and the use of the facilities has developed steadily. Initially, the board members used the Cullinet Trendspotter package, which Chairman Sir John Harvey-Jones described as "altering our whole way of working". The Pilot software from the Intelligent Office Corporation has now been selected for the next stage of development. Directors will use the new system as a working tool in their own offices, and later it will replace Trendspotter in the boardroom.

Our research suggests that the business ethos of an enterprise has a significant influence on the willingness of the board to embrace new technology. Companies that are aggressively managed, constantly seeking opportunities for expansion, and committed to control seem to be one category that like boardroom systems. One vivid example of this is the Dee Corporation. Dee is a company that has grown rapidly by acquisition. Between May 1983 and April 1986 it made eight separate acquisitions, spending more than £700 million in the process and increasing its sales revenue from £70 million to £2.1 billion.

Dee's management philosophy is that the worst way to treat an acquisition is to buy a company and leave it alone. A buyer always pays a premium rate, so he must improve the company or lose money. To secure improved performance, the Dee board insists that:

- There should be a 'written constitution', telling divisional managers what they can and cannot do.
- The information flows from the divisions must be totally reliable and independent.
- The information should be presented in a consistent way, so that the board can tell at once whether each division is meeting its targets.

In this way, it is possible to avoid what Dee's development director, Tony Butler, calls "a debate about the data, not about the business". Dee therefore insists that information should be up-to-date, accurate, and well presented. Information systems are seen as crucial in meeting these three requirements. Information technology permits the divisions to report ten days after the end of the period. The Wizard software package is then used to consolidate the information, and the Resolve system (discussed below) is used to present it to the board. Mr Butler told us that he believes it is a serious mistake to leave the presentation of data to the finance function in a company, because "this function is 200 years behind in presentation and communication" — a view we transmit without endorsement.

Mr Butler emphasised that he valued very highly the way Resolve forms the graphs before the eyes of the board members. He also believes that the use of Resolve enlivens the otherwise tedious task of wading through masses of financial data and quickly highlights the current problems.

THE METAPRAXIS RESOLVE SYSTEM

The Resolve system used by the Dee Corporation was developed and is marketed by a company called Metapraxis. One of the directors of Metapraxis is Professor Stafford Beer, an originator of cybernetics and a man who has devoted much of his working life to the study of knowledge and its uses. In our quest to find an appropriate working environment for Drucker's New Entrepreneur, we regarded Professor Beer's qualifications as distinctly promising.

The system consists of two software modules — Resolve and Vision — that interact with each other and with the users. Resolve is a database management system designed to hold key operational facts about a company and its strategic business units. Vision is an operating system that controls the various types of displays available from the system — computer graphics from Resolve, output from proprietary database services or inhouse computer systems, slides, videotex, video recordings, live television, or film. Vision can also be used to control the physical environment in the boardroom — closing curtains, dimming lights, etc.

Before describing the system in more detail, it is useful first to describe the backgrounds of its originators and the uses to which it is now being put. None of the senior staff at Metapraxis comes from a background in conventional data processing. They all previously held line management or staff jobs in large enterprises, mostly with a financial or corporate-planning emphasis. Their motivation in establishing the company was to address the difficult problems of control — especially financial control — in a large and complex business. Was there a way to reduce the complexity of this task? Could experience be shared? The founders of Metapraxis also held a common view about how boards like to manage. Boards, they believed, subscribe very sincerely to the ideas of devolution and delegation — as long as things are going well. But if an operating unit begins to miss its sales or profit targets, the board will feel obliged to find out why and to take remedial action quickly. Their aim was therefore to create an environment in which danger points could be identified and investigated immediately.

At present, there are four main application areas for the system. The first is for financial control in any large business. The second is to control the economy of a nation — Metapraxis is now building the database for the national economy of a republic in Africa. The third is to monitor the total exposure of a bank in securities and currencies, and in respect of certain clients. And the fourth — which took the company by surprise — is as the front end of a huge project-control application. Resolve and Vision will be used in this way by a company that is about to develop a set of computer and communication applications costing $700 million. The system will be used to identify modules that are exceeding cost or time budgets.

The Resolve configuration we examined had two screens and a substantial equipment room behind the screens. (It would not be possible to equip many boardrooms in this way without gutting some of the more elegant buildings in Paris, London, Rome, Stockholm, and elsewhere.) A complete profile of each of the operating divisions is held in the Resolve database — facts and figures about sales, profits, inventories, debtors, creditors, and investments. Metapraxis admits quite openly that the task of assembling this database is far from trivial. The company works with the client's own staff and (if necessary) financial consultants to set up the database. Once in place it can usually be maintained relatively easily, by linking it to the routine accounting systems. If necessary, Resolve can itself be used as a means of consolidating corporate accounts.

Resolve contains a series of display templates, such as graphs and bar charts. In principle, any set of data can be imposed on any display template. For example, an executive might request a graph of monthly profits from all units over two years. Within 15 seconds the graph is compiled and displayed. The graph might show that one unit is below target, and the executive suspects that this is because it is in a declining product market, such as asbestos. The executive therefore requests the system to display profit and loss figures for all asbestos-based businesses. With a simple command, every graph can be converted into its underlying numbers.

The display and environmental facilities provided by the Vision operating system are controlled by a soft keypad displayed on the screen. The keypad appears, for example, with 1 for television, 2 for public videotex, 3 for slide projector number one, and 4 for slide projector number two. The user has in his hand a real keypad like a domestic television remote control unit that he uses to select whichever medium he wishes to display. Thus, a Resolve analysis of the performance of a business may be accompanied by a slide showing its plant or offices.

The remote controller is also used to specify Resolve graphics. Menu items can be selected to indicate that the display required refers, for example, to the business in France; specifically to its travel company; its debtors; covering two years; in bar chart form. Thus the formula for the desired display is assembled parameter by parameter, with short cuts available to indicate (for instance) that the same display is required for Italy. Regular users will quickly grow to understand the structure of the database, and can simply key in the codes for the display they want without using the menu.

A great deal of thought and care has gone into the design of this system. The infrared control panel is congenial to use, because it is reminiscent of a domestic television controller. The Resolve graphs are assembled quickly, but not so fast as to make them seem instant or prepackaged. In fact, one has the distinct impression that the computer is thinking about the problem before displaying the answer. The depth of data in the system gives it a very spatial feel, somewhat reminiscent of the MIT Media Room with its so-called dataland/helicopter effect. Pie-charts are not used at all, because they cannot deal with negative values.

Resolve also contains some innovative presentation features. As year-to-date figures build up against year-end forecasts, the system does a simple arithmetic projection of its own. This is known by the users as 'the creeping-reality factor'. The system can also be asked to report on the ten most apparently anomalous results in a given period. It scans the whole database for the highest standard deviations. Some of these may be readily explained (because they refer to start-up units, for example), but others may be of great significance.

USING COMPUTER-GENERATED GRAPHICS TO PRESENT MANAGEMENT INFORMATION

The Resolve system described above makes extensive use of computer-generated graphics. The potential for using computer-generated graphics as a means of presenting management information in a concise and comprehensible manner has been recognised for some time. (We addressed this topic in some detail in Foundation Report 40 — Presenting Information to Managers.) However, there are dangers in using graphics in this way. Robert Widener, the chairman of the Intelligent Office Corporation and an expert in the field of computer graphics, believes that many senior managers distrust charts because of the lack of standards or conventions. For example, within the same series of charts, different colours might be used on different charts to represent the same concept — performance below budge*, say. Other causes of confusion are non-zero axes and logarithmic scales. As a consequence, senior managers feel uneasy about using charts as a support tool for major planning, performance-review, and decision-making meetings.

Mr Widener argues that the way to make computer-generated graphics a valuable management tool is to integrate inexpensive colour graphics terminals and large-image colour projectors with the mainstream computing systems. By using a series of carefully tested graphics standards, which management has approved and understands, and by developing programs that condense and summarise the mainstream data, it is possible to introduce the output from the organisation's computer systems into the decision-making process. The Widener solution is doubtless workable. Another route (followed by Metapraxis) is to set up and control the imagery used, ensuring that the quality, intelligibility, and accuracy of each chart are acceptable. We have little doubt that systems like that of Metapraxis can be highly effective in bringing management's attention to bear on the problem areas of any business.

Despite the limited effective use of computer graphics in the past, it is clear that computer-generated graphics can improve management's understanding of complex issues. As technology costs continue to fall, and as experience with these systems increases, computer graphics systems will be used more and more both in meeting rooms and on the desks of executives.

THE JUSTIFICATION FOR BOARDROOM SYSTEMS

Many people, particularly in the information systems departments of large companies, are sceptical about the worth of boardroom systems. We noted with interest that Metapraxis hardly ever tries to sell its system through the systems function. Metapraxis sells either direct to the board or through the finance function. There may be some companies for whose boards such a system would be inappropriate. Some critics regard them as mere gimmickry — as little more than expensive slide projectors. In our view, this view is excessively jaundiced. Boardroom systems should be judged not on whether they embody high-grade or low-grade technology, but on whether they improve the performance of the board. At one company we visited, the director we interviewed stated that the decision-making environment had improved since the boardroom system was installed, but he was unsure whether this was due to the system, or to the horseshoe-shaped table installed at the same time. The shape of the table allows each participant to see the presenter and the displays in comfort. (Interestingly, the table cost more than the system.)

When the true cost of the participants' time is considered, meetings of senior managers and directors are very expensive occasions, and the financial implications of decisions made at such meetings are considerable. At this level the expense of installing a boardroom system can be justified in terms of apparently marginal improvements. Even the expense of a mere slide projector, where the slides cannot get out of sequence or be upside down, where it is possible instantly to go back to an earlier display, and where the content can be amended at the last minute or as the debate develops, may well be justified. In the real world, we have found that a large number of small differences in perception, understanding, comfort, information, and many other factors can make the difference between good and bad decision making. The provision of the right systems in the boardroom — systems that are flexible, unobtrusive, easy-to-use, and consistent in presentation style — contributes in many instances to the process of improvement. Seeking to quantify the improvement is, in relation to the expenses and earnings that boards deal in, a supreme exercise in futility.

There are other reasons for installing sophisticated technology in the boardroom besides facilitating the decision making of the board. For example, the systems are often used by corporate staff — planners and finance staff — to explore and develop policy before it is submitted to the board. This may be a disadvantage if the chairman likes the boardroom to be available at a moment's notice. Some companies may install a boardroom system because it is important to them to be seen to be up-to-date and to be using advanced technology. For example, a major aerospace company has built a very 'high-tech' boardroom at considerable cost. We suspect many of the facilities are used more often during visits by customers than during board meetings. The same could also be true of Toshiba's decision room in the Toshiba Intelligent Building that we mentioned earlier.

At the highest level, extensive databases and sophisticated graphics software may be available on computer systems devoted entirely to supporting the board. For example, the boardroom system developed for the Imperial Group incorporated a choice of more than 2,000 prepared graphs and tables. The chief executive officer and other senior executives were equipped with individual colour terminals, which they mainly used to display financial performance figures, trends and variances, routine management accounts, discounted cash flow calculations, and so forth. The system could also be used to display information from external online databases on share price movements and company performance data. A projector connected to one of the terminals enabled the displays to be shown on large screens for meetings and presentations.

Although the system has now fallen into disuse following the takeover of Imperial by the Hanson Trust, Imperial claimed that whilst it was in use its main benefit was improved management decisions. Apparently, it was used heavily just before the takeover.

The experience of two other organisations with boardrooms systems is described in Figures 2.1 and 2.2.

GUIDELINES FOR SUCCESS

We have identified several guidelines that should be followed if boardroom systems are to be used successfully.

Directors must want it

The initiative for a boardroom system must come from the board members themselves. The use of such a system is discretionary, and it cannot be forced on people. Boardroom systems will be used successfully only if the people concerned are happy to use the technology and are not frightened by it.

Identify the real requirements

The true motives for wanting to install a boardroom system may range from a genuine desire to make the board more effective to a wish to enhance the company's 'high-tech image'. Either motive is acceptable, provided it is clearly and honestly recognised.

Do not install more than can sensibly be used

It is best to install the equipment and facilities a little at a time. Start by familiarising the participants with new technology in the meeting room by using it to replace visual aids. More sophisticated features can then be added later. The ICI case illustrates the merits of this approach.

Colour and high-resolution graphics are essential

Senior staff do not want to sift through a mass of complex data. They prefer to see graphs and charts, prepared to a consistently high quality, that highlight trends and performance.

For all these reasons, the long-discussed but rarely adopted idea of the boardroom information system is for many (though not all) companies an idea whose time has come. At least in companies that wish to take firm and aggressive control of the operating results of their divisions, such systems will be used more widely and more effectively, gradually becoming commonplace. In more passive companies, they may remain a rarity.

Figure 2.1 ICL's boardroom system

ICL has a meeting-room product called Pod that it both uses and sells.

Pods have been installed in ICL's offices in Sydney, in Reading, in Ireland, and in its Putney headquarters. The Putney installation is used by ICL's corporate board and the board of the United Kingdom company. ICL sells Pod in association with Lucas Interiors and AVM Audiovisual, although no sales had been made by the middle of 1986.

Pod is entirely independent of the traditional boardroom. Instead, it is a prefabricated, compact octagonal room (almost flat-packed) ready for assembly in an existing space. The ergonomics of the furniture, the choice of colours, and the lighting have all been purpose-designed for group-decision meetings. Each wall of the Pod is used for a different display purpose (whiteboard, 35mm projection, videotex display, external database display, overhead projector, etc.). The room is also equipped for videoconferencing and videorecording. All displays are controlled from an infrared control box at the centre.

ICL developed Pod in conjunction with the Sloan School of Management at MIT, with assistance from Michael Scott Morton.

Figure 2.2 The boardroom system at Northwest Industries

Northwest Industries, a Chicago-based industrial and engineering conglomerate with a turnover of $2.3 billion and employing 41,000 people, is the widely accepted pioneer of end-user executive and boardroom systems.

The systems development work began in 1976, and the system was used from 1977 to 1985. The project was initiated by the chief executive officer, and the ultimate design of the system largely reflected his style and point of view.

He felt that most of a chief executive's job is planning and devising strategy. He did not want distilled financial analysis on internal performance. Instead, he wanted to focus outside the company and its operating groups. He wanted information on competitors, acquisition candidates, and other outside financial forces. Northwest acquired financial information (including 20-year projections) on 5,000 companies, as well as building databases containing information about its ten operating companies. Through these databases, the chief executive and his 200 corporate staff were able to run sophisticated projections on the implications of buying and selling companies.

The main benefits of the system were that senior staff had at their fingertips the kind of information needed to make large, complex decisions quickly. For example, a steel company within Northwest requested a major capital expenditure of about $500 million. The system was used to build a model of the steel-making process and solved the problem for half the money. The chief executive and his corporate staff also felt that the system allowed them to make better and faster decisions about acquisitions and de-acquisitions.

CHOOSING A BOARDROOM SYSTEM

Meeting-room systems range in cost and capability from as little as $15,000 for a simple personal computer linked to a video projector in an existing room, to more than $300,000 for a system where an extensive range of hardware and software facilities are custom-built into a room.

The basic combination of a personal computer and a video projector can be used as an alternative to a conventional slide projector. Video projector technology has improved considerably during the last few years, and costs have dropped significantly. However, even with expensive, high-resolution graphics software and equipment, the quality will not be as good as that of professionally prepared 35mm slides. Nevertheless, a basic meeting-room system has the advantage that 'electronic slides' can be prepared at the last minute, and can even be amended during the presentation as a result of discussion. In one company we visited, the group's consolidated results were taken straight from the mainframe computer and converted automatically to slides for presentation to the board by the financial director. Conventional slides could not easily have been prepared in the same time. It was even possible to incorporate into the presentation the results from the German subsidiary in a month when these figures were not available until the morning of the board meeting.

More importantly, the same system can enable a meeting to use any software available on a personal computer. The most frequently used software is the ubiquitous spreadsheet and associated graphics software. We know of several examples where boards of directors and other groups of executives use spreadsheet software interactively during meetings to evaluate alternative courses of action. For example, the directors and corporate planners in one organisation used such a system to evaluate a takeover opportunity. They were able to build a model that allowed them to see the effects of a variety of courses of action. Many more possibilities were considered than would normally have been the case in the time available, and the availability of a large display made it easy for all participants to contribute.

The basic level of meeting-room system can be enhanced by adding facilities such as:

- A video recorder/player.
- Connection to internal computers.
- Connection to external information services and value-added network services.

Software should be easy to use
Ease of use, including easy access to data, is an essential requirement and one that is often unsatisfactorily met. The system being developed by ICI uses touch screens and menus of options to help overcome this problem. Other systems use the familiar infrared remote-control unit and a soft keypad on the screen. Several organisations are developing specialist software to make it easier to access mainframes and external services from personal computers.

Make the equipment simple to operate
Many meetings are highly confidential, and it is important that the equipment in meeting rooms can be operated by the participants themselves. Clearly, this means that participants who wish to use specialist software (spreadsheets, for example) will need to be familiar with it. Although senior staff will be prepared to undergo training in how to use specialist software, few people will submit to training in how to use a room. Therefore, the basic operation of the equipment in the room must be be obvious, easy, and, as far as possible, automatic.

Do not be too clever
One company installed a modified overhead slide projector inside a lectern. The presenter could place foils on the projector and, by a system of mirrors, they would be back-projected onto a screen behind him. One director who was unfamiliar with the system came in to prepare for a meeting and tried to remove the familiar-looking projector from the base of the lectern and place it on the table. His efforts resulted in severe damage to the projector, and it was never used again.

Use specialists to install the system
Boardroom systems are often installed when a company is moving offices or when an existing boardroom is being refurbished, and there is a great temptation to leave the installation and location of equipment to interior designers or architects. A key to success is that the whole environment should be correct — lighting, ergonomics, software, ease of use, etc. There are a few companies that specialise in the installation of meeting-room systems, and it is prudent to seek their advice. We heard of one company who had had a high-resolution system with a special screen installed back-to-front!

DECISION CONFERENCING

Another approach to improving the decisions of a group of people is the decision-conferencing method developed by Dr Larry Phillips of the Decision Analysis Unit at the London School of Economics. (Dr Phillips spoke about his method at the Foundation management conference held in Torquay in November 1983, and a summary of his presentation can be found in the notes published after that conference. A fuller description of the method is also included in Foundation Report 49 — Developing and Implementing a Systems Strategy.)

A decision conference consists of a two-day workshop attended by the decision maker and the various people who have an interest in the decision, together with an independent 'facilitator'.

The first task is to agree on the problem to be solved (objective-setting), and the participants then discuss possible solutions that may be worth considering. Next, they discuss the criteria that they could use to evaluate the different solutions, and they make subjective judgements about the value of each solution. For example, if the criteria were benefits and costs, they would judge the relative benefit and relative cost of each solution on a scale of 1 to 100.

The facilitator uses a portable computer and a large teleprojection screen (so that everyone can see the results) and displays a chart showing the position of each solution on a benefits-versus-costs matrix. The ensuing discussions may then lead to the addition of other solutions or to the definition of different evaluation criteria. Finally, the participants agree on the solution that best meets their criteria.

Decision conferences are particularly appropriate where the potential benefits and risks associated with a particular decision are high, where the number of opinions is large, and where a high degree of subjective judgement is required. One company, ICL in the United Kingdom, has used decision conferencing to reach a large number of decisions, including:

— Choosing between alternative strategic options.

— Allocating research and development budgets.

— Developing recovery and growth plans.

— Deciding how to respond to increased competition or changes in the marketplace.

— Formulating organisational change.

— Developing industrial relations strategies.

— Investigating mergers and acquisitions.

— Comparing test marketing options.

— Analysing alternative production and distribution facilities.

— Allocating sales resources.

Butler Cox was recently involved in a highly successful decision conference in an insurance company that was incurring very heavy costs because it was supporting too many bespoke underwriting policies. The conference showed very clearly that most of the profit was made on a small number of basic policy types and that the large number of bespoke policies contributed very little. The company subsequently changed its marketing approach in order to concentrate on the basic policy types.

Dr Phillips describes another decision conference held by a company in the household appliance industry. The managing director believed that technology-based opportunities for new business were being neglected. He arranged a decision conference to seek a better investment plan. In the objective-setting phase, the company decided it should expand into new business areas over the next seven years. The decision-conference participants then debated how to achieve that goal.

After an hour's debate, the participants were asked to allocate resources to the different product-based divisions, with some resources being set aside for new businesses. The targets for income and expenditure were in a range covering the best and worst cases. Next, the participants assessed the potential benefits of the investments. When all this data had been entered into the computer, the results of the model were displayed. They held two surprises. The first was that the existing investment plans were highly suboptimal and that the results of the group could be improved by reallocating resources within the existing product groups. More surprisingly though, the model showed no investment in new businesses. Indeed, it showed that it would be unprofitable to divert investment from the existing businesses. Dr Phillips reports that the managing director was both disappointed and puzzled by this finding. Could his instinct that new ventures were necessary be wrong?

The next day the answer to the dilemma began to emerge. In discussion, the managing director often referred to consequences beyond the seven-year horizon of the model. The model was rerun with a fourteen-year instead of a seven-year limit, and it now began to allocate resources to new businesses even in the early years of the plan. The managing director's instinct had been right after all. The company had been heading at cruising speed for the edge of a cliff.

The decision conference is a specialised and realistic derivative of the management games that were widely using in training courses in the 1960s. Its special value is that it relates not to a fictitious company invented by the course organiser, but to the actual business of the participants. The technique certainly makes sensible use of the computer, leaving the task of generating ideas for possible solutions to the humans, but helping them to explore the value of the solutions in a detailed and structured fashion. It also creates an environment in which all concerned are seen to play at least some role in the decision making. We do, however, know of many firms where the chief executive would see this feature as a disadvantage.

Chapter 3

Helping groups of people to communicate better

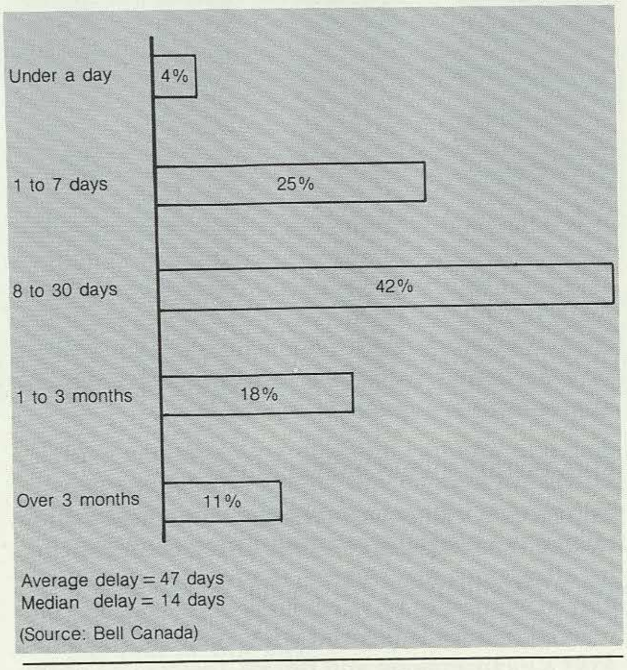
So far in this report we have considered ways of making meetings more effective, either by the use of boardroom systems or by the use of decision conferences aided by computers. But is this the best or the only approach? In Drucker's Age of Discontinuity travel itself is expensive, time-consuming, exhausting, and sometimes dangerous. Is it possible to avoid bringing people together physically every time they need to confer? Teleconferencing facilities, whereby a number of participants are simultaneously involved, range from full-motion videoconferences held in specially built conference rooms, supported by colour facsimile and other presentation aids, to the simple audio-conferencing facilities provided by modern telephone systems. Computer conferencing and computer-based messaging systems (electronic mail) permit asynchronous communications between groups, and the use of computer terminals by executives offers other opportunities.

TELECONFERENCING

Of the various means of teleconferencing, audio and full-motion video are probably the best known. Still-video snapshots can also be exchanged (often called slow-scan or freeze-frame teleconferencing), as can drawings (electronic blackboards), or page copies (facsimile). There are also options for large-group gatherings, in which hundreds of viewers watch a video presentation that is followed by a live question-and-answer session, usually transmitted via an audio network. These events are often more like television productions than business meetings, but they are part of the wide generic class of meetings called teleconferences.

The cost of using a teleconferencing system has often been justified by projected savings in travel costs, and new users are almost always drawn to this idea. A study conducted by Bell Canada more than a decade ago suggested that while only 10 per cent of business people thought that all meetings were candidates for teleconferencing, 47 per cent thought that many were, and 41 per cent that some were; only 2 per cent of business people thought that no meetings were suitable candidates for teleconferencing. Thus, the business community seems to be more than ready to consider teleconferencing as a substitute for face-to-face meetings. Moreover, there is plenty of evidence that the delay and inconvenience involved in setting up face-to-face meetings are clearly recognised. Figure 3.1 shows the Bell Canada study's findings concerning the interval between the recognition that a meeting is necessary and the date of the actual meeting. The apparent advantages of teleconferencing (as shown in Figure 3.2) are clear.

Figure 3.1 Delay between identifying the need to meet and actual meeting



Average delay = 47 days
Median delay = 14 days
(Source: Bell Canada)

Figure 3.2 Advantages provided by teleconferencing

Prevent meetings *not* being held
Pre- and post-meeting teleconferences
Timeshare scarce talent
Minimise relocation of key staff
Locate facilities in optimum place
Optimise organisational structure
Optimise communication code
Improve CEO leadership

⇒

Better management
Improved white-collar productivity
Cost control

Ten years of experience, however, have produced few convincing examples of direct travel substitution. Indeed, in some cases, travel increased with the use of teleconferencing. Travel patterns may well change as a result of using teleconferencing, but probably not in predictable ways, and, almost certainly, teleconferencing will not substitute directly for travel. Nonetheless, there is evidence to show that teleconferencing can help reduce the amount of travelling, or eliminate certain types of unnecessary travel, and projected travel cost savings are often the most obvious quantitative justification for acquiring teleconferencing equipment.

The most successful teleconferencing systems have been installed to meet specific needs or to address specific tasks. Teleconferencing should not be installed as a general-purpose utility, nor should it be installed as an experiment. Such approaches lead to passing interest and intermittent use. To make effective use of teleconferencing, managers must be convinced that they are getting value for money and that they are receiving support in accomplishing important tasks and in making important decisions.

Teleconferencing systems may be divided into three groups, according to the type of information transmitted:

- Full-motion video.
- Still video.
- Audio.

It is obvious that audio teleconferencing requires high-quality audio transmission, but it is sometimes forgotten that video teleconferences can also be made ineffective by the lack of high-quality audio. Some rules of thumb for determining when the use of a particular form of teleconferencing may be appropriate are given in Figure 3.3.

Figure 3.3 Rules of thumb for deciding on various forms of teleconferencing

Full-motion video

Consider using only when you can afford it.

Use when a task requires motion displays (for example, to show TV ads or moving mechanical parts).

Use when more social presence is needed (for example, for executive sessions).

Still video

Use when focus is on flip charts, overheads, drawings, documents, or other simple graphics.

Use for technical discussions.

Select a graphics system carefully, based on your needs (personal computer graphics may be perfectly adequate).

Audio

Use when visual communication is unimportant.

Use when you cannot afford visual audio.

Text

Use when participants have trouble scheduling meetings.

Use when participants are comfortable using keyboards.

Use when tasks are adaptable to text-only communications or when computer-based resources are important.

(Source: Adapted from R Johansen and C Bullen, Harvard Business Review, March/April 1984)

FULL-MOTION VIDEOCONFERENCING

Full-motion videoconferencing is the most sophisticated, and expensive, form of teleconferencing. Its attractions are clear — it provides the closest approximation to physical presence — but its commercial history is littered with failures, including AT&T's Picturephone and British Telecom's Confravision. And in Japan, NTT has recently abandoned its plans for a public videoconferencing service, although it will still continue to promote and install private inhouse systems.

Many failures in audio- and videoconferencing are caused by the inability of the users to adapt to the new 'culture' required to make the most effective use of teleconferencing. This problem is not necessarily solved by using more sophisticated technology, as is illustrated by one of the most successful video teleconferencing systems we heard about. The private, four-city system at Ohio Bell was originally assembled from surplus videotape equipment. It is not a sophisticated system, and therefore telecommunications experts tend to dismiss it. Yet it works. Indeed, when frequency of use is taken as the measure of success, it is much more successful than most high-technology systems.

Figure 3.4 describes the experience of American General Corporation in using full-motion videoconferencing. This case history shows that, despite initial scepticism, full-motion videoconferencing can be successful, provided that it is installed to meet a specific requirement.

One of the leading suppliers of full-motion videoconferencing systems is Compression Labs Incorporated (CLI) of San Jose, California. Delegates on the Foundation's 1984 Study Tour visited CLI and saw demonstrations of live videoconferences. CLI provides two types of system — a single-screen semi-portable model that can be wheeled to wherever there are suitable transmission facilities, and a two-screen built-in system, with the second screen being used to display diagrams. The typical cost of the semi-portable system is about $150,000, whereas a fully featured 'boardroom' system would cost about $500,000.

CLI's technology is being marketed in the United Kingdom, South Africa, Australia, and the Middle

Figure 3.4 Videoconferencing at American General Corporation

American General Corporation is the fourth-largest shareholder-owned insurance company in the United States. The company provides a variety of financial services as well as insurance. In 1980, American General began to consider the use of videoconferencing for communication between key employees in its 100-plus subsidiary companies in the United States. It set out to answer the following questions:

— Who would use videoconferencing?

— For what purposes would videoconferencing be used?

— What kind, and how many, of the company's 16,000 employees would participate in videoconferencing?

To find answers to these questions, American General employed the services of two specialist companies, who carried out a $40,000, six-week internal study that probed the attitudes, viewpoints and preferences of executives and specialists towards the concept of videoconferencing. The study revealed that almost all the respondents considered face-to-face communication to be a critical feature of their ability to perform well. Members of the personnel department, for example, thought that videoconferencing would be useful for other departments, but that interviewing prospective employees could never be successfully carried out by using television.

Supervisors and managers thought videoconferencing could be very productive in some unspecified way, but certainly not as a means of evaluating subordinates nor as a way of explaining the evaluations to them. Not surprisingly, marketing and sales personnel believed their physical presence in any business meeting to be absolutely essential.

After the initial enthusiasm for videoconferencing at the corporate level, the company's comprehensive internal study concluded that American General simply could not justify making any kind of commitment to videoconferencing.

One subsidiary company, Maryland Casualty Company, did not agree, however. Maryland's president felt that the study had done a good job in noting employees' fears and apprehensions, but that a corporate decision concerning videoconferencing had to be made on an honest estimate of the prospects of using a promising technology in a practical way. Despite the study's findings, and a tacit acknowledgement that adapting to any new technology would not necessarily be easy, he and his colleagues at Maryland Casualty intuitively believed videoconferencing to be worthwhile.

The president of American General Corporation agreed to Maryland Casualty's proposal to share equally the estimated $1.7 million cost of installing three videoconference rooms. The rooms are in locations (Sacramento, Houston, and Baltimore) where Maryland Casualty has key regional offices and American General has subsidiary locations. Later, a fourth room was added at Nashville, another key centre for the American General companies.

American General selected digital videocompression equipment manufactured by Compression Labs Incorporated of San Jose, California. All four of American General's videoconferencing rooms were operational by November 1981.

Initial estimates were that the use of the videoconferencing system could reduce travel costs by 19 per cent, while simultaneously decreasing unproductive employee hours spent in aircraft.

The transmission costs of a typical videoconference lasting about one hour are between $600 and $1,200; with an average of six participants, savings of $6,000 in travel costs were anticipated, together with considerable reductions in stress on the people involved.

In some decision-making situations, American General found that the need to travel disappeared completely. For example, whilst transferring all data processing activities to one centralised location, the managers concerned were able to decommission their decentralised systems and replace them with one main computer through a series of videoconferences over a period of three months. As many as 20 people at different American General offices participated in these complex data processing changes. At no time in the changeover was a face-to-face meeting necessary.

Nonetheless, American General has not experienced a dramatic reduction in travel expenses during its four years of increasing use of videoconferencing.

The company has found that video meetings are better structured, agendas are more carefully prepared and adhered to, and videoconferences are invariably shorter than face-to-face meetings. The end result is not only shorter meetings, but noticeably higher-quality decisions arrived at in a more timely fashion.

Also, videoconferences often involve personnel who might not otherwise have travelled to conventional meetings. A case in point involved the marketing department's plan to create a common policy that could be sold throughout the United States. The complex plan that was needed to establish a common policy was developed exclusively through the use of videoconferencing. The plan was formulated over several months at regular intervals in video meetings involving as many as 20 people from different offices. It is unlikely that all of the participants would have been able to meet on a regular basis if they had had to be physically present at a meeting.

To make videoconferencing truly cost-effective throughout American General, the company is considering expanding its system from the present four locations to as many as ten.

East by Plessey, and by Sony in Japan. Delegates on the Foundation's 1986 Study Tour of Japan visited Sony's Media World and saw a demonstration of Sony's videoconferencing system (which is represented diagrammatically in Figure 3.5 overleaf). The CLI codecs used by Sony allow the video signal to be transmitted at rates ranging from 1.5M bit/s to as little as 384k bit/s. Sony showed a video that compared the reception achieved with different transmission rates. The picture quality at 384k bit/s was still very acceptable. The Sony system has seven main features:

— High-resolution full-colour motion pictures can display simultaneously images of the participants and document/graphics images.

— The system can be equipped with two face-to-face cameras, one close-up camera, one document/graphics camera, one camera for the presenter/conference chairman, two video projectors, and an electronic writing board and tablet.

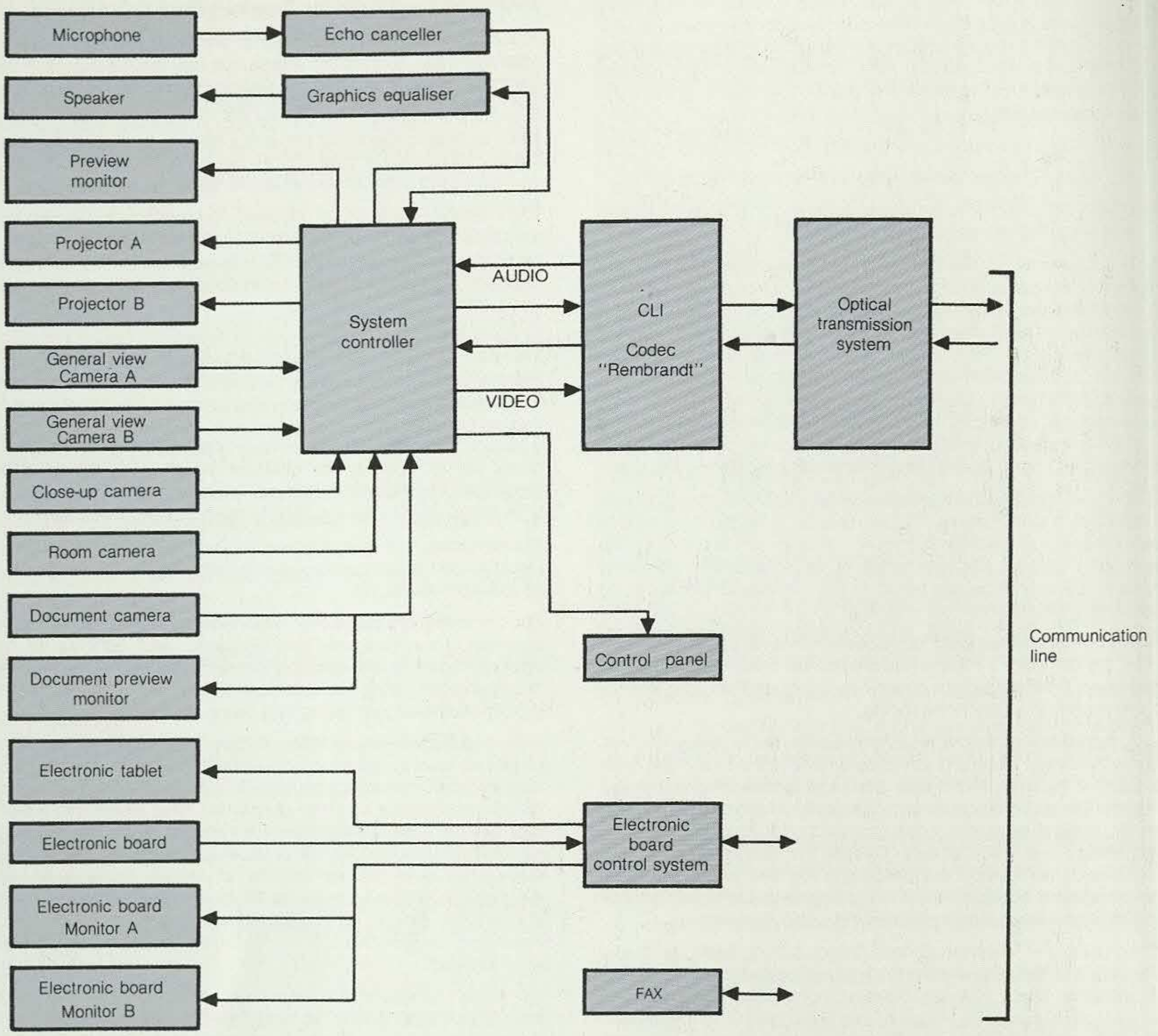
— A split-screen feature can accommodate a large meeting consisting of six to ten participants at one end of the link.

— The close-up camera can be controlled from either side of the conference, enabling selection and zoom-up display of any object or person.

— The CLI codec achieves highly efficient compression, enabling transmission of a close-to-natural picture, even with quick movements.

— Conversion between NTSC, PAL, and RGB video makes the system suitable for international conferences.

Figure 3.5 Block diagram of teleconference system at Sony Media World



— Video, audio, graphics, and data are transmitted over a single channel.

Sony has three conference rooms — Media World, at corporate headquarters (2 km from Media World), and at the Atsugi plant (50 km from corporate headquarters). The systems at Media World and corporate headquarters are linked by a 20M bit/s optical fibre, whilst the Atsugi lines operate at 1.5M bit/s. Sony has found that video teleconferencing is efficient for 'repeat' meetings. For an initial meeting, people still prefer to meet face-to-face. In April 1986, the system was in use only at Sony, but the product will be marketed before the end of 1986. One possible application area being promoted in universities by Sony is 'telelectures'.

The system is designed on a modular concept, which means that it can be used to configure systems ranging from a full-scale studio (as at Media World) to a 'rollabout' package. Sony is developing a new type of television camera, based on CCD (charged couple device) technology. This camera will be less obtrusive than the cameras presently used, and will require less light. (The lighting in the teleconference room visited by Study Tour delegates was very bright and hot.)

STILL VIDEOCONFERENCING

Experience suggests that still videoconferencing can provide many of the benefits of full-motion videoconferencing but at a much lower cost. However, it will still be necessary to install much of the same specialised equipment, especially cameras and good-quality audio equipment. The main advantage of still videoconferencing is that the communications costs are much lower.

Still videoconferencing is appropriate for technical discussions and for meetings where the participants already know each other. It is also easier to set up a still videoconference quickly because it is easier to obtain the required communications links at short notice.

Sometimes, this type of teleconference is basically an audio conference with graphics. Hoffman-LaRoche Laboratories, for example, uses audio teleconferencing with remote slide projection to carry out new-product training for its large, dispersed sales force. Using teleconferencing in this way ensures that information about new products reaches the entire customer base quickly, though such uses of videoconferencing are not related to decision making.

We understand that Procter & Gamble is experimenting with a freeze-frame videoconferencing system based on IBM PCs. The system is thought to comprise three black-and-white 23-inch monitors, three cameras, an overhead projector, a slide projector, and facilities for hard copy. It uses dial-up telephone lines and transmits black-and-white images in eight to ten seconds. Grey-scale images take 30 to 35 seconds to transmit.

Still videoconferencing may have a role to play in conjunction with full-motion videoconferencing. Some experiments have suggested that full video is useful during the first few minutes of a conference because it helps to break the ice. Thereafter, still video can be used, with a consequent saving in the bandwidth required.

AUDIOCONFERENCING

Audioconferencing is the cheapest means of teleconferencing, but it is, of course, suitable only when it is not necessary for all the participants to be able to see diagrams and documents relating to the discussion (though use of facsimile transceivers can permit documents to be exchanged). The term audioconferencing can be used to describe two quite different types of conference — a conference between two separate groups of people, each group sitting in a special conference room with special facilities, or a conference between several participants conducted via ordinary telephones.

Special audioconference facilities have been marketed for many years but have not met with much success. A typical conference table would incorporate a built-in high-quality loudspeaker and directional microphone for each participant, a system of pushbuttons to ensure that only one participant's voice is transmitted at a time, and lamps to indicate which remote speaker is talking. Such systems usually require special dedicated telephone circuits. Nowadays small portable units are available and can be placed on any meeting-room table and connected via a standard telephone socket. Nevertheless, even these compact devices are meeting with only limited success.

In the United Kingdom, British Telecom offers audioconferencing services through its Network Nine service. Three different kinds of service are offered, with a range of supporting equipment. The first service is called Group-to-Group, where two or more physical meetings are to be linked. The second service is the Individuals-to-Individuals service, where a set of people scattered all over the world can join in one discussion. Finally, there is the Group-to-Individuals service, which is used (for example) if a board is meeting while two or three of its members are abroad.

To support these services Network Nine offers slow-scan television for diagrams, charts, or drawings. A 40-second transmit time is used on a 64k bit/s digital line or an analogue line. The Network Nine audioconferencing system is called Orator. The Orator terminal is placed on a table, with microphones spread around the table and a loudspeaker for each participant. We found Orator to be simple and convenient to use once the participants have overcome the tendency to regard the loudspeaker as an invisible person. Network Nine also offers an Orator multipoint bridge, so that several Orator meetings can be interlinked.

In a crisis, a telephone conference can provide a very valuable service because the reaction time and the decision-making process are shortened considerably.

Conference telephone calls can easily be set up through a modern PABX. Some PABXs permit up to six calls to be interconnected, but usually only one of these can be an external party. Multiple external party conferences can usually be set up by arrangement with PTTs. As public telephone networks become more advanced, it will be possible for users to make such connections without the need for operator assistance. However, in practice it is very difficult to conduct an effective telephone conference between more than three parties because of the difficulty of controlling the conference. If two people speak at the same time, the result is unintelligible.

Nevertheless, the use of conference telephone calls has spread rapidly across the United States, and is now being marketed actively in Europe by the

PTTs. Large multinationals such as IBM, Digital Equipment, Honeywell, Datapoint, Control Data, Pfizer, and Procter & Gamble all make extensive use of telephone conferences. The technique has found a particular niche in the United States financial market with leading brokerage companies and trading banks, such as Chemical Bank, Chase Manhattan, Morgan Stanley, and Merrill Lynch.

COMPUTER CONFERENCING

Computer conferences allow a group to arrive at a better decision, often in a shorter time and at a lower cost than via conventional meetings. However, they suffer from the serious drawback that the participants must all be willing and able to use keyboards. For this reason, computer conferences have seldom been used by more senior decision makers.

Computer conferencing is similar in some respects to electronic mail. However, whereas electronic mail is essentially one-to-one communication, conferencing is many-to-many communication. There are several fundamental characteristics of computer conferencing:

- Members of a conference submit contributions, or comment on the contributions of others, via a computer terminal.
- The computer software organises the contributions, and when members log on to the conference, they are informed only of those contributions they have not yet read — though they also have facilities to peruse earlier contributions if they wish to. Computer conferences are therefore self-documenting.
- Contributions may be made at whatever time and place is convenient to the member. Thus, there are no time restrictions (no one is ever late for the 'meeting'), and there are no geographic or time-zone constraints.
- Conference members have time to consider carefully and, if necessary, to research and verify their contributions.
- Conferences cannot be dominated by strong, eloquent, or quick-thinking personalities.
- Usually, there is a computer conference leader who organises and stimulates user interaction and is responsible for initiating and concluding the conference.

The first computer conferencing system was designed and implemented in 1970, and there are now hundreds of systems that use a computer to store and facilitate human communication. Some of these are highly sophisticated systems specially designed for computer conferencing, or even for a specific organisation. But many are commercially available electronic mail systems that happen to be used by a group involved in making a decision.

Of the leading conferencing systems, EIES, Participate, Confer, and Notepad are probably the best known. EIES (Electronic Information Exchange System) was developed at the New Jersey Institute of Technology by Murray Turoff (who originated the idea of computer conferencing in 1970). Turoff is now developing a new generation of conferencing system for IBM. A detailed study of the impact of EIES was carried out in the early 1980s, and its main conclusions are shown in Figure 3.6.

Figure 3.6 The impact of computer conferencing

One of the largest studies of the impact of computer conferencing was carried out by Starr Roxanne Hiltz and Murray Turoff of the New Jersey Institute of Technology in the early 1980s. The computer conferencing system used in this study was the Electronic Information Exchange System (EIES), which was used by several thousand academics in the early 1980s. It was designed to support the following types of computer-mediated communication:

- Managers-to-individuals or managers-to-predefined groups.
- Conferences that involved time-sequenced transcripts of group discussions on a particular topic. The facilities included voting, text searches, and automatic delivery of new material to individual users.
- Notebooks, which were text-composition and word-processing facilities that provided features for organising and distributing documents, as well as automatic notification of edits and modifications.
- Directories, which contained self-entered interest descriptions both for groups and for individual users.

EIES had several thousand users and more than 300,000 hours of use. Typical user groups consisted of between 20 and 50 people.

The main conclusions of Hiltz's and Turoff's study were that:

- Learning to use a new communication medium and to integrate it effectively into established work patterns is not easy. Although EIES members could learn the basic mechanics of using the system in a few hours, they did not become fully comfortable with it and were not able to utilise some of its more useful features (such as joint document production) until they had between 50 and 100 hours' experience of using the system.
- If a user group does not have one or more persons willing to take an active leadership role, which requires spending at least one hour a day online to organise and stimulate interaction, an application is likely to be a failure.
- Participants should feel that the task or activity is important enough that they are willing to make time to spend at least one hour a week online. Less regular participation leads to frustration both for group members, whose messages are not retrieved and responded to, and for the individual user, who forgets how to use the system and never becomes proficient and comfortable with it.
- There were no dramatic scientific breakthroughs directly attributable to the use of EIES during the two years of observation by the study team. However, there was progress towards clarifying theoretical controversies in most groups. There was also an increase in the number of professional contacts with whom active members of the system regularly interact, and there was a greater awareness of the varieties of work being carried out in the area of interest and of the availability of new sources and types of information useful in scientific work.

Participate was developed by Participation Systems Inc. and is available via Telenet and The Source. It is also marketed by Digital, who are themselves a heavy user of the system. There are now several hundred public computer conferences on The Source on a wide range of topics, both business and academic.

By using computer conferencing, it is possible to obtain the considered opinions of all those likely to be able to make a contribution to a decision, irrespective of where the participants are located. If the participants in the conference are in the habit of logging on to the system frequently, their contributions can often be gathered much more quickly than if a physical meeting were arranged. However, if this is not the case and the decision is complex and has to be made quickly, computer conferencing may not be appropriate, because it is difficult to force people to use the technique. Another drawback of computer conferencing is the absence of good graphics facilities, though some packages such as Augment and Genie (from Data Dynamics) do include graphics software.

Computer conferencing has been used most widely in the academic community. For example, scientists working in a particular field or on a particular problem may use computer conferencing to exchange information and ideas. In France, a powerful computer and communication network is used to provide services to a national research community, which includes several groups from the Centre Nationale de la Recherche Scientifique (CRNS), the universities and the INRIA sites at Rennes and Antibes. The services include an electronic mail system, a word processing package, and a conferencing service known as Continuum. In the parlance of Continuum, a conference is called a 'meeting' and a message from a participant is a 'transaction'. Every transaction is given a unique identifying code. The codes are used to search for and review past transactions. Every transaction is made available to, but not imposed on, every participant. One important aspect of the use by INRIA is that the setting up of meetings is completely at the discretion of the users. There is no attempt to enforce usage of the system.

During our research, we also came across several commercial organisations that use computer conferencing, the largest of which was Procter & Gamble in the United States, with several thousand users. For competitive-advantage reasons, Procter & Gamble has never talked publicly about its computer conferencing applications.

The commercial experience to-date shows that computer conferencing can be a valuable tool where a group of geographically dispersed professional staff (not just academics) are working on a specific problem of project. However, it can clearly also be used even where all the participants are located in the same building, particularly where heavy schedules make it difficult to arrange physical meetings in a reasonable time.

Nevertheless, we believe that computer conferencing (and teleconferencing) will continue to be used only in very specific situations. The plain fact is that most people prefer face-to-face meetings.

Chapter 4

Systems that aid decision making

There are many different types of systems that can be used to aid or support a decision maker. Almost every system, from a simple calculator through to large exception-reporting systems and 'what-if' models, can be used as an aid to decision making. In this respect, it can be argued that some progress has been made towards creating the information-rich environment for the New Entrepreneur. Not all managers are persuaded by the argument, however. Some of their criticisms, as we shall see, are valid. But sometimes systems that aid decision making are criticised on spurious grounds, such as a failure to take account of all relevant factors. In fact, such a system need not be comprehensive in its coverage, because the person using the system can consider any excluded factors.

This point is seen most clearly in the spreadsheets that are now the commonest type of decision-support system in commercial use. A manager may experiment with the cashflow implications of various plans using a spreadsheet system, but the final planning decision may (and in many cases does) depend on factors such as staff availability and the importance of creating flexible plans, which are not part of the cashflow model. Spreadsheets, and similar tools, are used primarily as convenient aids that permit more alternatives to be analysed, rather than as a means of speeding up the decision-making process. Thus in the example above, a superficial judgement of the benefit of using a spreadsheet system might be that it is merely saving the manager's time and that the quality of decisions is not improved because the calculations could have been carried out manually. In our research, however, we have found direct evidence that managers are obliged to consider a narrower range of options if every option has to be analysed in longhand. Fatigue and boredom supervene. Silly arithmetic errors creep in. Figures do not balance. The result is that a workable solution, which may be far short of what is attainable, is adopted. In other words, the decision-making process has been degraded. We found no managers who have used spreadsheets for budget and planning purposes who have willingly reverted to manual methods.

At present, the decision-making aids are used predominantly by professionals, middle managers, supervisors, and clerical staff. Nevertheless, as the penetration of computer terminals in offices has increased in recent years, an increasing number of senior managers have begun using computer-based systems as decision-making aids. How typical are these senior managers? Is the chief executive in the Age of Discontinuity almost obliged to become a computer user? A fierce debate rages about this topic, with some observers believing that in the future most senior executives will use systems of their own. John Kotter of Harvard University takes a more conservative view, however. First, he believes that fewer than ten per cent of executives and managers currently use a computer, and second, he believes that this figure is not set to change much in the next decade. Kotter believes that the real impact of systems technology is on the quality of information provided to senior managers by their staff, not on their ability to reprocess it for themselves.

We, also, do not believe that executive systems will spread very quickly through the boardrooms of Foundation members. But they will spread. Experience shows that senior managers value the ability to obtain factual information from a terminal, provided that it is organised for their convenience. In some cases they will be prepared to work with a system to control the presentation of the information, but they are rarely willing to input information to a system, and they are often reluctant even to use electronic mail. In fact, for many board members, the absence of a keyboard is a prerequisite for using information technology. Senior managers therefore need systems that are individually designed for their convenience, even though the systems will most likely incorporate standard modules of hardware and software. The implication is that data may need to be input or assembled specifically for use by board members, as is the case with the database used by the Dee Corporation, where data for each implementation is assembled by financial staff. Systems such as these are often described as executive information retrieval (EIR) systems. EIR systems are gradually coming into use in leading organisations. We believe that the growth in their use will be steady but not spectacular.

Figure 4.1 describes the main types of computer facilities that can be used to aid decision making at different staff levels. During the research for this report, we identified more than 100 examples of systems that aid decision making. For the sake of clarity, we have divided these systems into five categories:

- Systems that provide access to data.
- Systems that manipulate data.
- General-purpose decision-support systems requiring major development effort.
- Systems that help to organise thinking.
- Expert systems.

SYSTEMS THAT PROVIDE ACCESS TO DATA

There are a great many situations where the availability of the right data can have a significant impact on decision making. One problem is that system designers rarely understand what kind of information will be really useful to managers. Conversely, managers are often unaware of the type of information that could be made available to them. At present, the range of data available in electronic form from bureaux services is growing rapidly. Organisations aware of the possibilities can gain significant commercial advantage by providing their managers with access to relevant data. For example, a large retail chain is reputed to have made over $1 million in a single day as a result of purchasing in electronic online form the most detailed weather forecast information available. It was able to predict an imminent heatwave and to adjust the stocks in its stores accordingly. Delegates on the 1986 Foundation Study Tour of Japan were told of a similar decision-support system that used weather forecast information relating to storms at sea to spot potential fresh fish shortages, so that stocks of frozen fish could be adjusted accordingly.

We identified many examples of systems that provide people with access to data for decision-making purposes, including:

- The Reuters Monitor system.
- A videotex-based price look-up service for pharmaceutical products.
- A content-addressable text-retrieval system used to access market-research interview results.
- A value-added network service used as an aid for decisions about petroleum trading.
- A production-reporting system showing, amongst other things, an analysis of production waste products by type.
- A legal database used by lawyers.
- A sales information system using an advanced flexible query language.

Figure 4.1 Main computer facilities to aid decision making at different staff levels

Staff category	*Main computer facilities to aid decision making*
Managers	Specific systems to aid decision making (often incorporates graphics), personal computing, information retrieval
Professionals	Specific systems to aid decision making, personal computing, information retrieval
Clerks	Specific systems to aid decision making, information retrieval
Secretaries	Information retrieval
Typists	Information retrieval
Sales representatives and regional managers	Specific systems to aid decision making.

At present, the data from each available system has to be accessed separately. In the future, we expect the scope and sophistication of data-access facilities to increase, so that they will provide the ability to link data from many databases, even though these databases use different database management systems, operating systems, and hardware configurations. Certain technological developments must take place before data-access facilities of this type become widely used (see Foundation Report 51). We believe that database interfaces will increasingly be based on the SQL language, which is now emerging as a de facto standard for database management systems and query languages. The interface with the human interrogator, on the other hand, will exploit both artificial-intelligence techniques to help the user clarify his requirements and data dictionaries to provide information about what knowledge is available. Already, entrepreneurial companies are being set up to provide data about databases. These companies act as business-information brokers, and this new area of activity is growing and changing rapidly. Foundation members should have at least a part-time group monitoring what is available in their industry.

SYSTEMS THAT MANIPULATE DATA

Systems that manipulate data are often used in conjunction with systems that provide access to data — for example, data for local use by a manager may be extracted from a file held on a mainframe computer and manipulated using a personal computer to create an ad hoc report. One organisation we visited has changed the way its data processing department responds to requests for ad hoc printed reports. In the past there was a strong demand both for new reports and for small amendments to existing reports (different sequences or subtotal levels, for example). Now, when faced with a request for a new report, the data processing department assesses the data requirements of the report, discusses with the user any related data that might be useful in the future, and then writes a program to extract the required data and format it on a floppy disk. Instead of a weekly printed report, the user now receives a floppy disc. The user then loads the data into a spreadsheet package (Lotus 1-2-3) and is responsible for analysing the data and preparing any reports. Apart from a dramatic reduction in the load on the data processing department, this approach has important benefits for the user in that he or she develops a better understanding of the data and is able to carry out different types of analysis, depending on the situation.

Another class of systems that manipulate data for decision-making purposes are operational research systems. These systems (often referred to as computer models) include simulation, linear programming, queuing theory, and critical path theory. When these systems are used to make or suggest decisions, they usually optimise a particular situation. For example, computer models have been used to make decisions about:

- Stock levels, so that stockouts and stock levels are minimised in the face of changing stock demand.
- Production and transport facilities to meet a variable pattern of sales demand for different products.
- Warehouse locations to minimise both lead times and operational costs.
- Price levels for a new product or service.
- The design of telecommunications networks, taking account of the various combinations of communications channels and traffic flows.
- The design of bridges where the effects of different loads and stresses have been simulated for different designs.
- The layout of production facilities.

Some modelling systems are large and complex and are expensive to develop and maintain (such as sophisticated marketing and pricing models). Others are quite simple and inexpensive to implement (such as a simple program that optimises the packing of standard products of differing sizes onto a pallet of standard size). Generally, the more sophisticated the model becomes, the greater the difficulty and the effort involved in ensuring that the underlying decision-making rules remain up-to-date.

The more complex modelling systems are most likely to be used as decision aids, where the decision suggested by the system is reviewed (and perhaps modified) by the person ultimately responsible for the decision.

GENERAL-PURPOSE DECISION-SUPPORT SYSTEMS

The objective of a general-purpose decision-support system is to provide answers to ad hoc questions. The designers attempt to build a database and to provide a range of modelling facilities that are comprehensive enough and flexible enough to satisfy a wide range of requirements. The MIS projects of the late 1960s shared this aim. Most of these projects failed because the technology was immature and the ambitions of the designers too broad. Since then, computers have become powerful and cheap enough, and software expertise has developed sufficiently, to provide a reasonable chance of success, especially if the scope of the project is carefully constrained. The ICI and Imperial boardroom systems described in Chapter 2 are examples of general-purpose decision-support systems.

These systems often take the form of a specially constructed bespoke database, together with a range of data-access and manipulation (or modelling) facilities that allow the data to be used by a variety of decision makers for a variety of purposes. Usually, in addition to a high-level data-access language, they incorporate a wide variety of predefined enquiries and display formats to make them easier to use by executives who know relatively little about computer systems. The Imperial boardroom system had over 2,000 such displays, accessed by a system of menus.

The value of using such a system, and the situations in which it will be valuable, will become clear only after people have been trained to use it and management has come to understand its strengths and limitations. The development of a general-purpose decision-support system requires substantial investments of time and money, and therefore needs to be carefully planned. We have noted an increasing trend for large organisations to invest in constructing either executive information-retrieval systems or more broadly based decision-support systems.

These investments can be difficult to justify using conventional cost/benefit criteria because of the uncertain nature both of the decisions that are to benefit from such systems and of the benefits themselves. We have identified two essential prerequisites for the successful development and use of a general-purpose decision-support system. First, the system should complement other inputs to the decision-making process. For example, there should be a natural balance between the facilities or data that the system provides and the facilities, data, and knowledge provided by other systems or tools and by the human decision maker. Thus, if it is easier for the decision maker to use a calculator or a spreadsheet program rather than a sophisticated computer system, the sophisticated system is likely to remain unused.

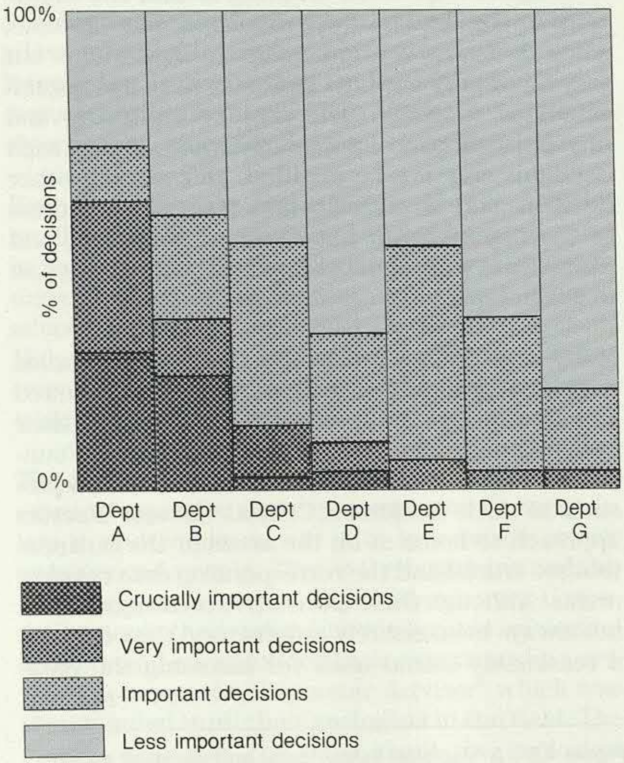
The second prerequisite for success is the availability of relevant and useful data in a suitable form. A general-purpose decision-support system is designed to be used by a variety of decision makers in a variety of decision-making situations, so it is very difficult to predict the data requirements of all the individuals who might use the system. We believe that, before setting out to store new data in an electronic form or rearranging existing sets of electronic data, a systematic attempt must be made to match the data needs to the types of decision that will be supported by the general-purpose system.

The first step is to identify the more important decisions (or types of decision) that are made either on a regular or on an ad hoc basis. There are several ways in which this can be done, but our experience has shown that a very effective approach begins with face-to-face interviews with identified decision makers in key areas. The interviews are followed by senior management workshops during which an initial list of important decisions and corresponding data requirements is prioritised and extended.

The analysis is carried out at the department or section level and therefore does not include corporate-wide decisions made by senior management. The proportions of decisions in each category for each department or section can then be displayed graphically. Usually, there will be a considerable imbalance in the importance of decisions made in different areas of the organisation. A typical illustration of this imbalance is shown in Figure 4.2.

Once the more important decision-making areas of the business have been identified in this way, together with the associated data flows, improvements to the data-delivery systems can be determined using conventional systems analysis techniques. However, our experience of carrying out this type of study has shown that technology-based improvements are not necessarily the best approach. Often, changes in the organisational structure and/or new insights about the data required by those involved in the flow are far more important than the technology used. Also, we have found that many of the most important decisions are taken on an ad hoc, rather than on a routine, basis. Predicting ad hoc data needs often requires considerable foresight, not to say inspiration.

Figure 4.2 Imbalance in the importance of decisions made by different departments



Once the desired improvements in the data-delivery systems have been determined, the next step is to identify the data requirements. Organisations should do this by answering the following questions:

- Is all the data that could significantly improve the quality of each important decision available or potentially available? And, if not, is the data that is available still sufficiently valuable to justify its inclusion in a general-purpose decision-support system?
- Is the available (or potentially available) data currently being delivered to the decision maker(s) in an effective and relevant way?
- If not, how can the situation best be improved, and is the optimum data-delivery solution likely to have a significant effect on the quality of important decisions?

Because of the importance of data for computer-based decision-support systems of all kinds, it is essential to balance the various needs to capture data against the costs of doing so and the limitations of the data that are available. For example, some decisions are important to individuals but may be of only minimal importance to the organisation as a whole. The cost of capturing and manipulating large volumes of data to support such decisions may not be justified. In contrast, other decisions may be critically important to the success of the organisation, but relevant, accurate, and timely data to support these decisions may not be available.

Many large organisations have carried out detailed data-analysis exercises to identify the data required to make different types of decision within their own organisational environment. And some Foundation members have used alternative techniques such as Jack Rockart's Critical Success Factors approach to home in on the areas of the business that are crucial and the corresponding data requirements. Although these alternative techniques have not always been entirely satisfactory, they do form a reasonably sound basis for assessing the data-capture, data-storage, and data-access requirements.

In evaluating which technique or combination of techniques to use, it is important to remember that it will be necessary to capture data required by a variety of applications that may have only medium or low decision values, as well as data related to high-value decisions. The cumulative effects of many low-value decisions can be significant. This need should not be interpreted as a rationale for capturing and storing all the data that is available, however.

One drawback of a data-analysis exercise it that it can produce a mass of apparently conflicting data requirements. We have found that the complex situation identified by a data-analysis exercise can be clarified by constructing a simple decision-analysis matrix that relates different data needs to the value of the decisions to be taken, highlighting where one source of data can be used in several decision-making situations, or where data is not available. An example of such a matrix is shown in Figure 4.3. In the matrix, we can see, for instance, that some of the data to support decision B is not available, while decision F (which has a medium decision value) could be supported by providing access to data captured to support the high-value decision C.

Figure 4.3 A 'decision value', data, and decision matrix

Decision and its value		*Data needed*						
		1	*2*	*3*	*4*	*5*	*6*	*7*
A	H	Ⓗ						
B	H			Ⓛ				Ⓗ X
C	H		Ⓗ	Ⓗ		Ⓗ		
D	M	Ⓛ				Ⓛ		
E	M				Ⓜ			
F	M					Ⓗ		
G	L			Ⓜ			Ⓜ	
H	L						Ⓗ	Ⓛ X

H High decision value
M Medium decision value
L Low decision value
Ⓗ Data is highly important to decision
Ⓜ Data is of medium importance to decision
Ⓛ Data is of low importance to decision
X Data is not available by any means

SYSTEMS THAT HELP TO ORGANISE THINKING

Ideas processors can be used by managers to help them organise, compare, and evaluate complex arguments. This type of system (Brainstorm and Notepad are two typical examples) has become available in recent years to help the decision maker to organise the thinking process. Brainstorm, for example, is described by its publishers (Caxton) as an ideas processor and (less modestly) as the "most effective aid to creative thought since the pencil and paper". And all for £49.99. Other available systems include the American Thinktank, and Framework, an integrated suite of programs from Ashton Tate.

Most of the systems currently available allow the user to enter several ideas, expressed in textual form, in the sequence in which they occur. The user can then define the relationships between the ideas and use the system to group them in a variety of ways. The packages, in effect, attempt to mechanise the processes of induction and original writing. Some of the systems allow the preferred structure of ideas to be used as the skeleton of a report, with the author using a word processor to supply the extra text.

There are also a few packages that have in-built expertise on some areas of decision making. In these systems, the dialogue between the system and the user helps the user to define the problem, and the system may then give advice on the way to proceed.

In future, ideas processors and similar types of system will develop to become more sophisticated, will make greater use of graphics, and will allow several alternative structures to be evaluated.

EXPERT SYSTEMS

Expert systems are perhaps the most exciting possible tool for the New Entrepreneur. They have attributes that correspond neatly with Drucker's world of uncertainty and volatility, such as their ability to deal with unstructured and even fuzzy information. They break away from the old-fashioned mould of conventional data processing systems. They seem innovative and powerful. They mobilise the very knowledge that Drucker says is both the scarce resource and the driving force in the Age of Discontinuity.

In 1983 the Butler Cox Foundation published a report on expert systems, Report 37. Our broad conclusion was that within every large and complex enterprise, there were a few — a very few — high-payoff possibilities for using an expert system. If such a possibility existed, it could require a very substantial investment to exploit it. In that report we said it would be at least three years before expert systems became a generally usable tool. Our view provoked considerable anguish and resentment among the most strident advocates of expert systems. But it also brought considerable relief to many of our members, who were worried that they had not invested more effort in the area. It gave them one less short-term problem to worry about.

With hindsight, we are even more certain that our cautious view was the right one in 1983. We must now consider what, if anything, has changed in the intervening years. To allow our readers to judge the present state of development of expert systems on a basis of genuine understanding, we propose to review at some length progress in the field. We will return to this topic in more detail in a Foundation report, to be published in 1987, which will review the business use of expert systems.

Artificial intelligence has been defined by P H Winston as "the study of ideas which enable computers to do the things that make people seem intelligent" (see reference 2). In other words, artificial-intelligence systems must cope with qualitative as well as quantitative information, ambiguous and 'fuzzy' logic, and rules of thumb. The answers provided by artificial intelligence may not always be optimal, but they should always be valid. Specific techniques such as 'frames' and 'rules' allow artificial-intelligence systems to represent knowledge in ways that are much easier for a manager to understand than the conventions of algorithmic, procedural data processing.

Expert systems are one manifestation of artificial intelligence. Others (which will not be considered in this report) are robotics and natural-language understanding through semantic analysis. We also adopt the distinction recently proposed by Luconi, Malone, and Scott Morton (see reference 3) between expert systems and expert support systems, which is explored below.

The aim of an expert system is to take some scarce, existing expertise and experience and to encapsulate it and communicate it to less expert or less experienced people. That is the beginning and the end of expert systems. The Schlumberger Corporation took their most knowledgeable geological analysts and encapsulated their experience in a system known as the 'Dipmeter Advisor' which was then handed to all their geologists in the field. The system examines the data about the geological characteristics of a trial well and provides expert advice to field geologists.

Expert systems also aim to solve problems that are not amenable to traditional systems analysis. One of the earliest and most successful implementations of an expert system is XCON, developed by Digital Equipment Corporation in conjunction with Carnegie-Mellon University. XCON uses over 3,000 rules and 5,500 component descriptions to configure the detailed specifications of VAX and other computer systems to match the requirements of customers. The system first determines that the proposed configuration will actually fit together and work. Then it generates a map of the layout and power connections that will make it the best configuration possible. The expertise enshrined in XCON is important because a delay in commissioning a system is a major source of customer irritation, delayed payment of rental or purchase moneys, and deferred cash flow. XCON has now been in use for four years and Digital is quite certain the system is financially successful.

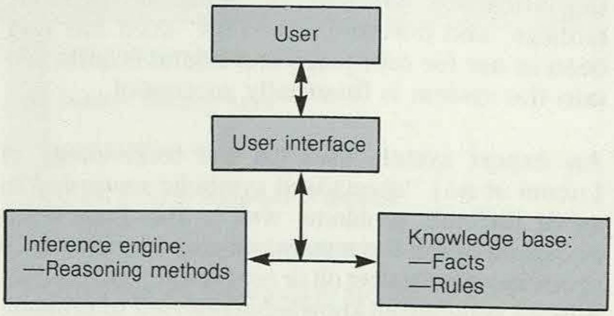
An expert system uses (in the terminology of Luconi *et al.*) "specialised symbolic reasoning to solve difficult problems well". The knowledge encapsulated in the system is highly specific to the problem area (finding oil or configuring computers); it is not generalised knowledge relevant to problem solving in general. The reasoning of the system is symbolic and often qualitative, rather than being based on straightforward numeric calculations. In addition, an expert system will often perform at a level of expertise above that of the non-expert human.

One important difference between expert systems and conventional data processing systems is that the latter employ precise algorithms. If a payroll application works properly, there is only one correct pay figure for each employee that it can possibly reach. In contrast an expert system uses heuristic (rule-of-thumb) reasoning to determine (for example) that one pattern of geological results is more likely than another to match the trial well data.

Earlier in this report we distinguished between systems that make a decision and implement it (such as automatic pilot systems) and those that merely propose a decision for human consideration. Luconi *et al.* propose the same differentiation in the field of expert systems. They describe expert systems that merely suggest a solution for human consideration as expert support systems — "computer programs that use specialised symbolic reasoning to help people solve problems well". In such systems, the knowledge incorporated in the expert system is accepted in advance as being inadequate to solve the problem completely. It will be expanded and supplemented by the humans in their dialogue with the system. We find that this differentiation between expert systems and expert support systems fits well with our thinking about the different ways of using information technology to improve decision making.

The three main components of an expert system are the user interface or window, the knowledge base containing the facts and the rules, and an inference engine containing reasoning methods. These elements are shown in Figure 4.4. The separation of the knowledge base and the reasoning method is as important in an expert system as is the separation of the data from the program in conventional data processing. As the problem changes or comes to be better understood, new rules can be added to the knowledge base without tampering with the old facts and reasoning methods. Experts (known as knowledge engineers), who are skilled at knowledge representation, work with the subject experts to extract the knowledge from their brains and transfer it to the computer. Not surprisingly, knowledge engineers are few and far between.

Figure 4.4 Elements of an expert system



(Source: Luconi *et al.*, reference 2)

There are several different ways of representing knowledge within the knowledge base, but the three most important knowledge-representation methods are production rules, semantic networks, and frames. Each is described briefly below.

Production rules provide a simple toolkit for building logical constructs of the form " If . . . it is raining, then . . . you need an umbrella." A medical diagnosis expert system might have a production rule that said:

If: (1) The patient has a fever, and
(2) The patient has a runny nose,
Then: It is very probable (0.9) that the patient has a cold.

A computer configuring system might have a rule:

If: (1) There is an unassigned single-port disc drive, and
(2) There is a free controller,
Then: Assign the disc drive to the controller port.

Another knowledge-representation method is called *semantic networking*. For example, it might be simpler to specify the above rule about assigning disc drives by supplying the knowledge base with all the information about which part numbers refer to drives, ports, controllers, etc. Thus, a cascade of devices, components, subcomponents, and so on is established in the system. Semantic networks are a very powerful tool for knowledge representation because many individual rules can be encapsulated in one network.

Frames are used to maintain a catalogue of attributes about an entity in the knowledge base. In the case of an electrical component, for example, its length, width, weight, and power requirements might be stored in the slots of a frame. A frame is somewhat like a record in a conventional database, except that it may also contain additional features such as 'default values'. If the default value for voltage requirements of a component is 110 volts, then the configuring system will assume 110 volts for all components unless otherwise indicated.

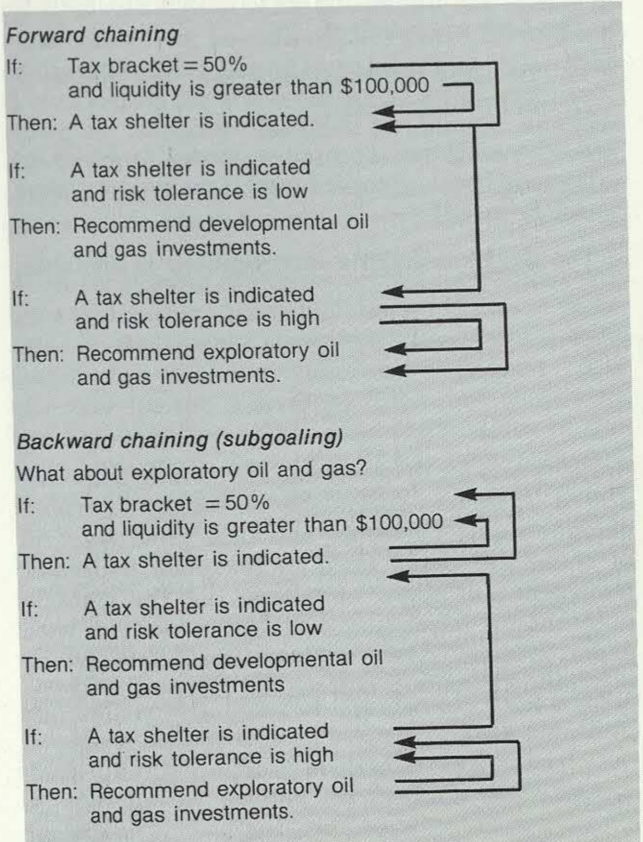
Production rules, semantic networks, and frames all help create the knowledge base upon which the inference engine will operate. The reasoning methods of the inference engine are intended to resemble those of a human being. The two methods most frequently used with production rules are forward and backward chaining. Figure 4.5 shows how these two reasoning methods would work for a tax advisor expert system. If a client's top rate of tax is 50 per cent, his liquidity is over $100,000, and he has high tolerance for risk, the tax expert says he should consider exploratory oil and gas investments. If he is more cautious, development projects are better suited to his investment and taxation needs. Forward chaining works through the logic towards the conclusion. Backward chaining starts from the other end with a question: are investments in gas and oil exploration appropriate to this client? It reaches a 'yes' or 'no' decision by moving backwards through the knowledge base.

To which kind of business problem can expert systems be applied? Luconi and his collaborators have attempted to build a grid (shown in Figure 4.6) which distinguishes between what computers are good at and what humans are good at. They categorise each potential system according to the data it requires, the procedures that it employs to reach an answer, the goals and constraints imposed by reality, and the strategies employed to decide which procedure to apply in support of what goals.

Four categories of system emerge from this analysis. The first and simplest are classical data processing applications, where the data is structured and the procedure is clear. The second, decision-support systems, are used where the data is only partially structured or is incomplete and where the rules for solving the problem are less than clear. The third category is the field of expert systems, where the system builder can encode some of the goals, some of the trial-and-error methods and strategies that people use to solve problems but that have previously been beyond the scope of computer systems.

Yet even the advocates of expert systems are obliged to admit that there are many cases in which some of the most vital of the information elements required to make a decision will be missing. The desirability of launching a new product may depend almost entirely upon the competitive response of other companies, which cannot be known in advance. How can a corporate plan take account of the health and happiness (or even sanity) of the chief executive who will (if it is adopted) be expected to implement it? "What this suggests," state Luconi, Malone, and Scott Morton, "is that for many of the problems of practical importance in

Figure 4.5 Forward and backward chaining



Forward chaining

If: Tax bracket = 50%
and liquidity is greater than $100,000
Then: A tax shelter is indicated.

If: A tax shelter is indicated
and risk tolerance is low
Then: Recommend developmental oil
and gas investments.

If: A tax shelter is indicated
and risk tolerance is high
Then: Recommend exploratory oil
and gas investments.

Backward chaining (subgoaling)

What about exploratory oil and gas?

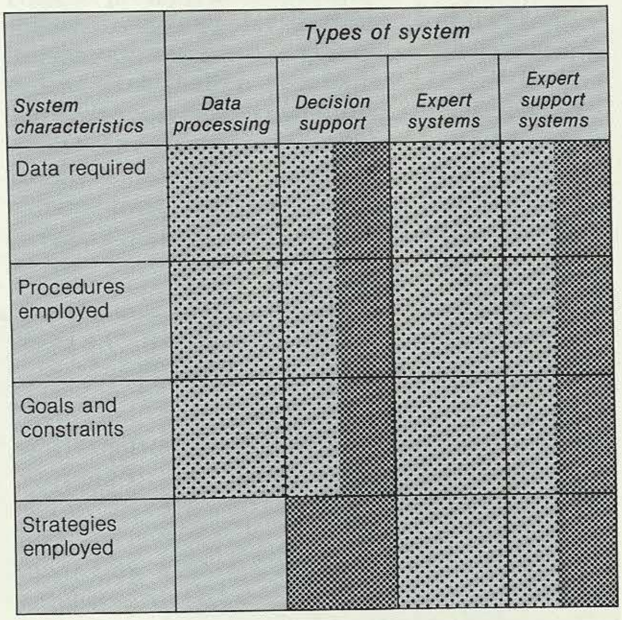
If: Tax bracket = 50%
and liquidity is greater than $100,000
Then: A tax shelter is indicated.

If: A tax shelter is indicated
and risk tolerance is low
Then: Recommend developmental oil
and gas investments

If: A tax shelter is indicated
and risk tolerance is high
Then: Recommend exploratory oil
and gas investments.

(Source: Luconi *et al.*, reference 2)

Figure 4.6 Characteristics of four types of system



	Types of system			
System characteristics	*Data processing*	*Decision support*	*Expert systems*	*Expert support systems*
Data required	░	░ ▓	░	░ ▓
Procedures employed	░	░ ▓	░	░ ▓
Goals and constraints	░	░ ▓	░	░ ▓
Strategies employed		▓	░	░ ▓

Key:

░ Best done by computer.

▓ Best done by people.

(Source: Luconi *et al.*, reference 2)

business, we should focus our attention on designing systems that *support* expert users rather than on replacing them.'' Hence the fourth category shown in Figure 4.6 — expert support systems. Luconi *et al.* conclude that pioneering organisations are leading the way with these systems and are staking out new territory (in terms of competitive advantage) that will be hard for latecomers to capture.

We are, on balance, more inclined to agree with the more bullish mood of American researchers than we have been in the past. Expert systems are now moving from the university classroom into the real world. During our research, we identified many decision-making situations in which expert systems were being used, or were likely to be used, including:

- A scheduling and costing system for property construction, where the system was being used to predict timescales and costs at an early stage in the project, before all the details were known.
- A system that suggests solutions to problems in integrated-circuit production.
- Systems for medical and plant disease diagnosis.
- Systems for analysing mineral-exploration data and predicting the likelihood of successful mining or drilling.
- Systems for insurance underwriting.
- The pricing of aircraft seats in response to customer demands as the time of departure approaches. North West Orient and other airlines in the United States currently use human experts to change the proportion of economy seats on aircraft as the departure time approaches. The objective is to ensure that the number of empty seats is minimised, whilst retaining the highest possible percentage of full-fare passengers. North West Orient has developed an expert system that performs better than the human experts, and it expects the system gradually to replace the human beings.
- An investment system that decides on the best 'home' for funds on a day-to-day basis, using up-to-date information about worldwide financial markets.
- A computer-component-selection system that decides on the components necessary to meet a particular customer order.
- A washing-powder simulation model that uses an expert system to predict the features of various combinations of washing-powder ingredients.

In the context of decision-making or decision-suggesting systems, expert systems can be thought of as extending the range of application of computer systems beyond that of conventional systems or operational research systems. In some decision-making situations, expert systems techniques can be used as an alternative to conventional data processing or operational research techniques. Where there is a choice, any doubt about which type of system to use can usually be resolved by considering the degree of uncertainty, the degree of complexity, and the stability of the decision-making environment. Expert systems are likely to be the best approach if:

- The decision rules are uncertain and subject to frequent amendment.
- A conventional computer model is likely to become highly complex (and if an expert system can be used).
- The decision-making environment is unstable.

REPORT CONCLUSION

This report set out to answer the question ''How can information technology be used to improve decision making at senior and board level?'' It has shown that, so far, the impact at this level has been limited, although boardroom systems and techniques such as decision conferencing are beginning to be used to advantage. Group communication aids, such as teleconferencing and computer conferencing are also beginning to be used.

Systems aids for decision makers include database-access systems, spreadsheets, general-purpose decision-support systems, and ideas processors. All of these are being used increasingly by senior managers and board members. But the greatest potential for improving decision making lies with expert systems. Every organisation should now be evaluating the use it can make of expert systems.

Appendix

A framework for using IT to improve decision making

During our research for this report we developed a framework to help us categorise both the various roles that information technology can play in decision-making processes and the types of information system that are suitable in different sets of circumstances. In effect, there are four ways in which information technology can be used:

- To automate the decision-making process.
- To suggest decisions.
- To provide information or other aids for decision makers.
- To help groups of decision makers communicate with each other.

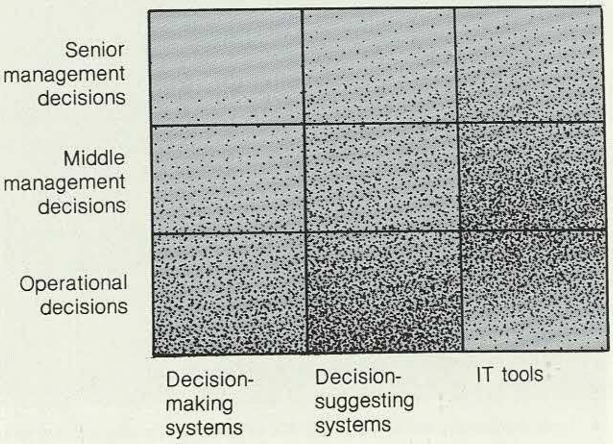
We believe that of all these categories, systems that suggest decisions should be treated with the greatest caution. In some situations, the decision-making rules can be defined only partially, and the computer system is used to suggest a decision that is checked by a person before it is implemented. However, although the need for human supervision might have been recognised at the design stage, a period of successful operation may lead the operators to place too much trust in the system.

At the beginning of this report we mentioned systems that automatically manage portfolios of securities on the world's stock markets. There is little doubt that these systems have proved cost-effective for the individual firms that use them. But following the recent wild fluctuations of the New York Stock Exchange, it has been seriously argued that the volatile state of the market has been caused by the aggregate effect of these systems. The systems overreact to changes in prices, and cause each other to overreact ever more extremely (in terms of control theory, the systems are acting as positive feedback systems, not negative feedback systems). At present, this explanation for the behaviour of the stock market is only an assertion, but it is a rather worrying one. But there are other equally worrying reasons to doubt the wisdom of relying on systems that suggest decisions.

Another recent incident, this time on an aircraft, also offers food for thought. The pilot and copilot were so confident of the decisions being made on their behalf by the automatic landing system that they failed to carry out basic checks on air speed and altitude. The aircraft landed too quickly and overshot the runway. Fortunately, no one was hurt. But if people are prepared to risk their lives by relying on computerised decision-making systems, it seems even more likely that reliance on such systems will result in unwise business risks. It is not impossible that the risks could be fatal for the organisation.

The relationships between the different levels of business decisions and the ways in which information technology may be used are shown in Figure A.1. The degree of shading represents the extent to which information technology is used now. Thus, at present, decision-making systems are used almost exclusively for operational decisions concerned with the day-to-day running of the business, although over time they will begin to be used increasingly for tactical decisions (that is, for decisions now made by middle managers and professionals; these decisions are primarily concerned with planning and with evaluating alternatives). Eventually, they might also be used for strategic

Figure A.1 The use of IT for different types of business decisions



decisions made by senior management, but not within the foreseeable future.

Decision-suggesting systems are also used today for operational decisions, and increasingly for tactical decisions. Over time, the use of this type of system will also extend to strategic decisions.

Information technology tools help human decision makers make the decision themselves. The tools include a wide range of facilities, including spreadsheets, routine analyses, database-access systems, variance reports, and complex 'what-if' models that allow the decision maker to consider a large number of alternative options. Their use at present is focused on middle-management decisions, although they are also used to a lesser extent for operational decisions and for senior-management decisions. Over time, their use for operational decisions is likely to diminish (because more and more routine decisions will be made by automated systems), whilst their use for management decisions is likely to increase as senior managers become more comfortable with using information technology.

An important class of information technology tools is what we call 'group-communications aids'. This type of tool allows a group of people charged with making a decision to communicate more effectively by using, for example, computer-generated graphics or teleconferencing facilities.

Having identified the main ways in which information technology can be used to improve decision making, we then identified the characteristics that determine when it will be appropriate to use different types of information system in the decision-making process. These characteristics are:

— Whether the decision-making rules are available.

— Whether the basis on which the decision is made is relatively stable. For operational decisions, the decision-making environment is likely to be reasonably stable. For strategic decisions, the environment may be highly unstable.

— The 'value' of the decision (high, medium, or low). The value is determined by the benefits from making the best decision and/or the penalties for making a poor decision. Strategic decisions are likely to be higher-value decisions than operational decisions, but the cumulative 'value' of low-level operational decisions can be high. For example, the decision about when to reorder stock and how much to reorder will be repeated many times. The 'value' of any one individual decision may not be particularly high, but the cumulative effect of ordering inappropriate quantities, or reordering at the wrong time, over

Figure A.2 Decision characteristics that influence the use of IT

	Type of use				
Decision characteristic	*System makes decision*	*System suggests decision*	*System aids decision making*	*Group communi-cations facilities*	*IT unlikely to be of use*
Decision-making rules available	●	●			
Decision-making rules not available			●	●	●
Stable environment	●				
Unstable environment				●	●
High or medium value	●	●	●	●	
Low value					●
Speed of response	●				
Accurate data required	●	●	●		
Relevant data available	●	●	●		
Relevant data not available				●	●
Large volumes of data	●	●	●		
Complex calculations	●	●	●		
One-off			●	●	●
Repeated regularly	●	●	●		
Responsibility of several areas				●	
Electronic culture established	●	●	●		
Electronic culture not established				●	●

● = Characteristic is likely to be a key determinant of the successful use of IT a sustained period could be very damaging.

- The speed with which the decision has to be made.
- Whether accurate or approximate data can be used.
- Whether relevant data is readily available.
- Whether large volumes of data have to be accessed.
- The number and complexity of the calculations that have to be performed.
- Whether the decision is one-off, or will be repeated in the future at regular intervals.
- Whether one person is responsible for the decision.
- Whether an 'electronic culture' is already established in the organisation.

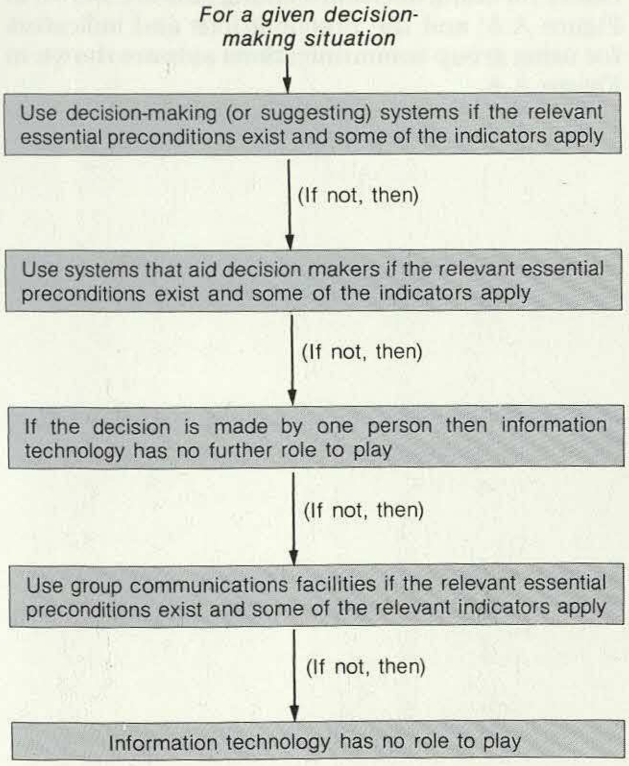
The relationship between these characteristics and the different types of information system is shown in the table in Figure A.2. (The table also contains a column showing where the use of information technology is likely to be inappropriate.) This table shows, for example, that:

- It is most likely that a system that automatically makes decisions can be built where the decision-making rules are available, the decision-making environment is stable, the value of the decision is high or medium, the decision has to be made quickly, the relevant data is available, and the decision is repeated regularly. Clearly, most (if not all) strategic decisions are excluded.
- A decision-suggesting system is more likely to be appropriate where the data and decision-making rules may be less reliable, the decision value is high or medium, but where the timescale is not so pressing.
- Information technology is less likely to have a role to play where the decision-making environment (data and logic rules) is unstable and where the decision value is low.

The information shown in Figure A.2 forms the basis for a framework (or methodology) for determining the most appropriate ways of using information technology for decision making. The methodology consists of a set of rules that determine when and how information technology can be used. The rules can be represented in the form of the flow chart shown in Figure A.3. By working logically through the 'if-then' rules, it is possible to determine whether:

- Information technology can be used to automate the decision-making process (either to make the decision or suggest a decision).
- Information technology can be used as an aid for decision makers.
- Information technology can be used as a communications aid for a group of decision makers.
- Information technology has no role to play.

Figure A.3 **Logical rules for determining when to use IT in decision making**



For a given decision-making situation

Use decision-making (or suggesting) systems if the relevant essential preconditions exist and some of the indicators apply

(If not, then)

Use systems that aid decision makers if the relevant essential preconditions exist and some of the indicators apply

(If not, then)

If the decision is made by one person then information technology has no further role to play

(If not, then)

Use group communications facilities if the relevant essential preconditions exist and some of the relevant indicators apply

(If not, then)

Information technology has no role to play

(For preconditions and indicators see figures A.4-A.6)

Figure A.4 **Rules for determining if systems that make or suggest decisions are appropriate**

Use a system to make or suggest a decision IF:

The following preconditions exist:

- Decision-making rules are available.
- The decision-making environment is stable.
- The quality of the decisions can be assessed.
- Relevant data are available.
- Both the system and the human must have a part to play in the decision (for systems that suggest decisions).

AND IF some of the following indicators are present:

- The decision value is high or medium.
- Timeliness if very important.
- Accuracy is important.
- Large volumes of data need to be accessed and/or manipulated.
- The decision-making situation is repeated regularly.

Figure A.5 Preconditions and indicators for using the four types of decision-making aids

Precondition or indicator	*Systems that provide access to data*	*Systems that manipulate data*	*Systems that help organise thinking*	*General-purpose decision-support systems*
Relevant data are available	P	P		P
The data are useful for decision making	P	P		P
Natural balance between system and decision maker	P	I		P
The decision maker is able and willing to use the system			P	
Timeliness is important	I	I		I
Large volumes of data need to be accessed and manipulated	I	I		I
Data already in electronic form	I	I		
Accuracy is important		I		I
Decision-making rules are not available		I		I
Decision-making environment is complex			I	
Comprehensive coverage of a topic is important	I			
Complex or intuitive logic			I	
Decision maker has a mental 'block'			I	
Decision value is medium or high				I
Data can be used in several situations				I

P = precondition
I = indicator

Figure A.6 Rules for determining if group communications facilities are appropriate

Use group communications facilities IF
The following precondition exists:

— The decision is to be made by a group with a shared understanding of the decision.

AND IF some of the following indicators are present:

— The decision value is high or medium.
— The decision-making environment is unstable.
— Relevant data and decision-making rules are not available.
— More than one area of the business is involved in making the decision.

The 'rules' consist of a set of preconditions and indicators. The preconditions and indicators for using decision-making (or suggesting) systems are shown in Figure A.4; the preconditions and indicators for using decision-making aids are shown in Figure A.5; and the preconditions and indicators for using group communications aids are shown in Figure A.6.

References

1. Keen P, Scott Morton S M. Decision Support Systems. Addison-Wesley, 1978.
2. Winston P H. Artificial Intelligence. Addison-Wesley, 1984.
3. Luconi F L, Malone T W, Scott Morton S M. Expert Systems: The Next Challenge. Sloan Management Review, Summer 1986.

BUTLER COX
FOUNDATION

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

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

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

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

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

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

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

Selected reports
5 The Convergence of Technologies
8 Project Management
11 Improving Systems' Productivity
15 Management Services and the Microprocessor
17 Electronic Mail
18 Distributed Processing: Management Issues
19 Office Systems Strategy
20 The Interface Between People and Equipment
21 Corporate Communications Networks
22 Applications Packages
23 Communicating Terminals
24 Investment in Systems
25 System Development Methods
26 Trends in Voice Communication Systems
27 Developments in Videotex
28 User Experience with Data Networks
29 Implementing Office Systems
30 End-User Computing
31 A Director's Guide to Information Technology
32 Data Management
33 Managing Operational Computer Services
34 Strategic Systems Planning
35 Multifunction Equipment
36 Cost-effective Systems Development and Maintenance
37 Expert Systems
38 Selecting Local Network Facilities
39 Trends in Information Technology
40 Presenting Information to Managers
41 Managing the Human Aspects of Change
42 Value Added Network Services
43 Managing the Microcomputer in Business
44 Office Systems: Applications and Organisational Impact
45 Building Quality Systems
46 Network Architectures for Interconnecting Systems
47 The Effective Use of System Building Tools
48 Measuring the Performance of the Information Systems Function
49 Developing and Implementing a Systems Strategy
50 Unlocking the Corporate Data Resource
51 Threats to Computer Systems
52 Organising the Systems Department
54 Integrated Networks

Forthcoming reports
Planning for the Future Corporate Data Centre
The Effect of IT on Corporate Organisational Structure
Choosing System Development Methods
Educating the Organisation to Exploit IT
Electronic Data Interchange

Availability of reports
Foundation reports are available only to members of the Butler Cox Foundation. Members receive three copies of each report. Additional copies may be purchased from Butler Cox. Reprints of the summary of research findings for each report are available free of charge.

BUTLER COX FOUNDATION

Butler Cox & Partners Limited
Butler Cox House, 12 Bloomsbury Square,
London WC1A 2LL, England
☎(01) 831 0101, Telex 8813717 BUTCOX G
Fax (01) 831 6250

France
Butler Cox SARL
Tour Akzo, 164 Rue Ambroise Croizat,
93204 St Denis-Cedex 1, France
☎ (161) 48.20.61.64, Fax (161) 48.20.72.58

The Netherlands
Butler Cox BV
Burg Hogguerstraat 791
1064 EB Amsterdam
☎(020) 139955, Telex 12289 BUCOX NL
Fax (020) 131157

United States of America
Butler Cox Inc.
150 East 58th Street, New York, NY 10155, USA
☎ (212) 486 1760 Fax (212) 319 6368

Australia
Mr John Cooper
Consultants (Computer and Financial) PLC
Level 7, 20 Bond Street, Sydney, NSW 2000
☎(02) 237 3232, Telex 22246 MACBNK
Fax (02) 237 3350

Italy
SISDO
20123 Milano – Via Caradosso 7 – Italy
☎ (02) 498 4651, Telex 350309 SISBDA I

The Nordic Region
Statskonsult AB
Stortorget 9, S-21122 Malmo, Sweden
☎ (040) 1030 40, Telex 12754 SINTABS