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End-User Computing

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The Butler Cox Foundation

THE BUTLER COX FOUNDATION

REPORT SERIES NO. 30

END-USER COMPUTING

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Abstract

The concept of end-user computing is relatively new. In this report the phrase is used to describe the activities of those users who play a direct, active and creative part in developing and operating their computer systems and who are largely responsible for their own applications and data. The purpose of the report is to clarify the nature of end-user computing and its relationship with the corporate data processing function.

The report indicates that a wide range of computing facilities are being used by a variety of end users to develop and operate a comprehensive range of applications. It also identifies the emerging function of an end-user computing support service. At present, end-user computing accounts for only a small percentage of the total corporate data processing budget and workload, but it is growing rapidly. The report shows that the development of end-user computing cannot be ignored by the corporate management services or data processing function and it concludes by providing guidelines for establishing an end-user computing support service.

Research team

The report was researched and written by a team led by *Charles Chang,* a senior consultant with Butler Cox in London. He has been active in the field of end-user computing since 1977. His contributions include work with ICL's End User Facilities User Group and with a specialist group of the British Computer Society. In addition he has contributed to a working group of the British Standards Institute which has been studying some aspects of end-user computing.

The research effort for this report was international, with interviews being carried out in the United Kingdom (by Butler Cox and Partners), in France (by Butler Cox, France), in Italy (by Sisdoconsult), in Sweden (by Statskonsult) and in the Netherlands (by SA Butler Cox NV).

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Butler Cox & Partners

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

Objectives of The Foundation

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

New developments in technology offer exciting opportunities — and also pose certain threats — for all organisations, whether in industry, commerce or government. New types of systems, combining computers, telecommunications and automated office equipment, are becoming not only possible, but also economically feasible.

As a result, any manager who is responsible for introducing new systems is confronted with the crucial question of how best to fit these elements together in ways that are effective, practical and economic.

While the equipment is becoming cheaper, the reverse is true of people — and this applies both to the people who design systems and those who make use of them. At the same time, human considerations become even more important as people's attitudes towards their working environment change.

These developments raise new questions for the manager of the information systems function as he seeks to determine and achieve the best economic mix from this technology.

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 the United Kingdom, France, Sweden, Switzerland, Denmark, the Netherlands, Belgium, Italy, South Africa and the United States.

The Foundation research programme

The research programme is planned jointly by Butler Cox and by the member organisations. Each year Butler Cox draws up a short-list of topics that reflects the Foundation's view of the important issues in information systems technology and its application. Member organisations rank the topics according to their own requirements and as a result of this process a mix of topics is determined that the members as a whole wish the research to address.

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.

Follow-up to this report

The research team who prepared this report would welcome the opportunity of discussing its findings with member organisations. If you would like to participate in such a discussion, please let us know the points on which you would like the researchers to expand.

THE BUTLER COX FOUNDATION

REPORT SERIES NO. 30

END-USER COMPUTING

CONTENTS

END-USER COMPUTING

REPORT SYNOPSIS

End-user computing represents a small but rapidly growing element of corporate data processing. This growth will present opportunities as well as problems for management services and data processing departments alike. End users in this context are individuals, typically middle-level professional and managerial staff who contribute actively to the development, implementation and maintenance of their own computing applications. The end users may be supported by intermediaries — departmental professionals or seconded data processing staff — who act as resident computing experts within the user departments.

For most organisations in the years ahead, the management services or data processing department will need to play an active role in the development of end-user computing, as one element of an all-embracing information systems strategy. As a starting point, the organisation's basic attitude to end-user computing — to encourage, discourage, or remain neutral — should be carefully considered and regularly reviewed. Each of these three options will affect the implementation of the organisation's overall strategy.

Organisations wishing to encourage end-user computing should, we believe, certainly establish an end-user support service. The aim of such a service would be to assist end users to employ their computing facilities most effectively, in their own interests and in those of the organisation as a whole. The service should be staffed by high-calibre people who have a sound understanding of computing techniques but who are primarily interested in the application of computing to solve business problems. Chapter 6 contains guidelines for establishing an end-user support service.

Access to corporate data is one of the key issues to be decided, as we explain in chapter 5. Should end users have direct access to corporate files, or should their access be indirect via extracted files? Another key issue is the evaluation and selection of end-user facilities and applications. Software evaluation is particularly important, and when new applications are proposed, the basic choice is whether they should be implemented by the end user or by the data processing department. Criteria for the approval of applications should be specified, and if end users are permitted to develop operational applications then procedures for ensuring security must be laid down. The end-user charging policy must also be carefully considered and defined.

Thus, three key organisational issues emerge. Should the computing expertise reside with an end-user intermediary or with seconded data processing staff? Should an end-user steering group be set up? Should an end-user support service be introduced?

End-user computing tends to employ standard hardware (from mainframes to microprocessors), but non-traditional software. On the software side, interest is focused on report writers and query languages; programming languages and system builders; decision support systems; and application packages. All of these are discussed in chapter 2.

A variety of report writers and query languages enable end users to retrieve information from established computer files, and some of these products can be used in different modes to match the expertise of the user. Data dictionaries can make report writers and query languages easier to use and less error-prone.

Programming languages and system builders are used by the increasing number of end users who are developing their own systems. A system builder is a set of software tools for building a complete application system. Examples of proprietary products include IBM's Data Mapping Program (DMP) and Sperry Univac's Mapper. The languages most frequently used by end users are Basic and APL, followed by Fortran and, to a lesser degree, Pascal.

Decision support systems enable end users to manipulate data so as to utilise the most appropriate application packages, and to present the information in the most suitable form. They are used mainly in academic and research organisations at present. Application packages have been modified by a few end users to suit their own purposes.

The results of our survey of end users are reported in chapter 3. The end-user applications examined in the survey fell into four groups — once-off applications, planning and management information, operational applications, and (overlapping the previous three) applications that interface with corporate data files. In terms of cost and effort, the bulk of the applications were in the second category, where a typical example was a system developed by an accounts department to provide monthly financial analyses for management. Specific operational applications among those surveyed included factory production scheduling, management accounting, insurance actuarial work, manpower accounting and charging, funds placement and loans financing, and construction project control.

The survey confirmed that organisations need to select both products and suppliers with care. The user-friendliness of products varies enormously. Microcomputers are increasingly important in end-user systems, yet few of the organisations surveyed had clear policies for their acquisition and use. Most of the organisations did not see a need for systems training for end users. We believe this to be a short-sighted view.

Most of the organisations in the survey actively encouraged end-user computing, and most believed that it would continue to grow. (Estimates of present expenditure on end-user computing ranged up to ten per cent of the total data processing budget.) But organisations appreciated that it will be very difficult to control end-user computing. In general, those organisations that had a policy for end-user computing related it to the organisation's broader information systems strategy. In our view, there is no other approach.

Over the next few years we expect that the most significant growth in end-user computing will be in operational applications, developed mainly by end-user intermediaries. In chapter 4 we predict that new families of easy-to-use software products will become available, from which end users can select the facilities they need. Hardware options will proliferate and the distinction between microcomputers and terminals will become less clear in an end-user computing environment. As hardware prices continue to fall in real terms, multifunction workstations (of which the Xerox 8010 and ICL PERQ are typical forerunners) will become attractive end-user computing tools. Local area networks will give end users access to more facilities, and end-user computing techniques will encourage managers and professional staff to adopt computer-based office systems. The power of end-user systems will grow as they embrace expert-system and natural-language abilities.

The forecast developments will widen the end-user population, particularly as decision support systems bring in more lower and middle managers and as office systems are used by more senior administrative staff and supervisors. As end users take on direct responsibility for more of their own computing activities, the role of the data processing department will change. Its development and maintenance workload will not increase as it has in the past, and it will relate to the end users on an arm's length basis. But there is no ideal role for the data processing department. An organisation's information systems policy will reflect the corporate structure and management style.

Thus, end-user computing can no longer be ignored by management services or data processing departments. Already some surprisingly large and complex systems have been developed and implemented by end users. In the future, more and more people within an organisation will be introduced to this type of computing, and more of their applications will be used to control a part of the day-to-day business operations. Effective planning for this growth means that organisations must act now to ensure that they are well prepared to manage the introduction and expansion of end-user computing. How best to do this is the theme of this report.

PREFACE

In the early days of general-purpose computing the end users of data processing systems could be categorised into two broad classes — commercial users and scientific users. Commercial users typically submitted batches of data to a central computer installation and the results of the processing were returned to them in batches. Early commercial users were not involved actively in the design and development of the computer systems they were using. These activities were carried out on their behalf by systems analysts and programmers. On the other hand, early scientific users very often designed, developed and operated their own systems.

Later, as software tools evolved and developed and as computer hardware became cheaper and more powerful, commercial users began to have more direct access to computer files through terminals. Some users began to specify their own requests for reports and interacted with the computer systems themselves (via report writers and query languages) to produce the reports. Some of the more numerate commercial users also started to use facilities such as modelling packages where, instead of using the systems development staff as an intermediary, they were able to produce for themselves the analyses and calculations they required.

To begin with, many scientific users did not make use of the early commercial computing facilities installed by organisations because the hardware tended to be fully occupied in processing the commercial applications. Instead, scientific users used specialised bureaux or dedicated stand-alone equipment. Many computer bureaux began by providing very powerful processors that could be shared by several scientific users. As the cost of hardware was reduced and its performance improved, minicomputers were developed, many of which were designed specifically to meet the needs of scientific users. For example, the early minicomputers produced both by Digital Equipment Corporation and Hewlett Packard were designed specifically for the scientific market. Today, however, most large organisations have sufficient computing capacity at their central installations to accommodate scientific users as well as commercial users.

The net result of the two parallel streams of development outlined above is that many organisations have a substantial (and growing) body of end users who are willing and able to use computing facilities in an active manner. In addition, microcomputers (which started life as hobbyist's toys) are now being installed increasingly as business tools. User-oriented microcomputer facilities such as VisiCalc and Micro-Modeller are introducing more and more business users to 'do-it-yourself' computing.

But the majority of the traditional users of computing systems can be regarded as passive users. They receive reports produced by computer systems, use modelling applications that have been developed by someone else, or use a terminal to obtain answers to predefined queries.

Such computer usage is not considered to be end-user computing for the purposes of this report. As we noted above, there is a growing body of end users who play a direct, active and creative role in developing the systems that they use. For the purposes of this report, end-user computing is concerned with the way in which these active end users employ their computing facilities. The key distinction between end-user computing and traditional computing is that the user, rather than the data processing department, is responsible for his or her computing.

End-user computing therefore encompasses the use of programming languages such as APL or Basic by end users to develop their own systems. It also includes the use of report generators by end users to define and produce reports, and the creative use of packages by end users to develop and run modelling applications.

Purpose and intended readership of this report

The purpose of this report is to clarify the nature and scope of end-user computing and to outline its role in relation to the corporate data processing function. The report shows that end-user computing is a major area of growth in many organisations, and its development cannot be ignored by the management services or data processing function within an organisation. The report therefore provides advice to managers of these functions so that they may develop the end-user computing component of their services in the most cost-effective way and within the organisation's overall information systems strategy.

Our research identified the emerging function of an end-user computing support service, and the report also provides general guidelines for those organisations wishing to establish such services. In addition, it provides particular advice to those who will manage such a service. Also, because the report emphasises the organisational and management issues associated with end-user computing, it will be of value to managers in the departments that make use of end-user computing facilities. The report also reviews the current status of end-user computing facilities (hardware and software) and, predicts the likely developments in such facilities during the next few years. Because the topic of end-user computing is relatively new, we believe that the report should also be of interest to suppliers of information system products.

Structure of the report

The report is organised in six chapters. Chapter 1 describes who the 'end users' are, and defines their characteristics and requirements. The main aim of the chapter is to provide a working definition of end-user computing for the remainder of the report. Chapter 2 contains a review of the end-user computing facilities that are commonly in use today. This chapter does not contain a detailed catalogue of products, nor any critical analysis of the facilities described. Instead, it presents a review of representative products that our research has shown are being used in end-user computing environments.

Chapter 3 summarises our research into end-user computing experiences. We interviewed a wide variety of end users who, between them, are using most of the facilities and products reviewed in chapter 2. The early findings from this interview research identified several common issues, and we set about substantiating those findings by asking all Foundation members, through a questionnaire, about their use of, and attitudes to end-user computing. Chapter 3 also summarises members' responses to the questionnaire.

Chapter 4 discusses likely future developments in end-user computing in terms of hardware, applications and software, and the likely changes in the profile of users. The chapter also suggests the ways in which end-user computing may converge in the future with other information systems (in particular office systems and decision support systems).

The final two chapters of the report focus on the management and organisational issues of end-user computing. Chapter 5 concentrates on the key issues confronting the management services and data processing functions as a result of the growth in end-user computing, and chapter 6 presents guidelines for establishing and running an end-user support service.

A short list of references is included at the end of the report.

CHAPTER 1

THE END USER

The concept of end-user computing is relatively new and there is, as yet, no commonly accepted definition of end users or end-user computing. The purpose of this chapter is to provide a common understanding of what we mean by these terms when we use them in this report. We define an end user as someone who plays a direct, active and creative role in his or her computing. An end user may therefore perform an element of development work. The distinguishing characteristic of such users is that, in many respects, they (rather than the data processing department) are responsible for their own applications and data.

Thus, end users include those who use a report-writer facility to define for themselves or for their immediate colleagues the reports that are produced, but exclude those who merely receive reports that have been predefined by someone else (even though the reports may be produced by the same report-writer facility). Similarly, end users include those who use a modelling package to develop their own modelling application, but exclude those who use the same package in a predefined way. End users who develop their own applications using languages such as APL and Basic are, of course, included within the scope of our definition.

We begin by describing the work of four professional study groups who have been working to define the characteristics of end-user computing. We then list the common characteristics of end users that our research identified and, finally, we describe the emerging role of what we term the end-user intermediary.

CHARACTERISTICS OF END-USER COMPUTING

Our research confirmed that, because the concept of end-user computing is still relatively new, there is not as yet any commonly accepted definition of the user of such facilities. Several professional study groups have, however, been working to define the characteristics and requirements of end users. We now review briefly the work of the four most prominent groups:

—The Codasyl End User Facilities Committee.

—The British Computer Society Query Language Group.

—The ICL End User Facilities Sub-group.

—The ANSI End User Facilities Task Group.

Codasyl End User Facilities Committee

The Codasyl End User Facilities Committee has been active since 1976, when it succeeded an earlier (and similarly named) task group that had been formed in 1972. The committee issued a Codasyl Journal of Development in December 1980 (reference no. 1), two aspects of which are of particular relevance to this report: the definition of end users, and the role of forms processing in an end-user environment.

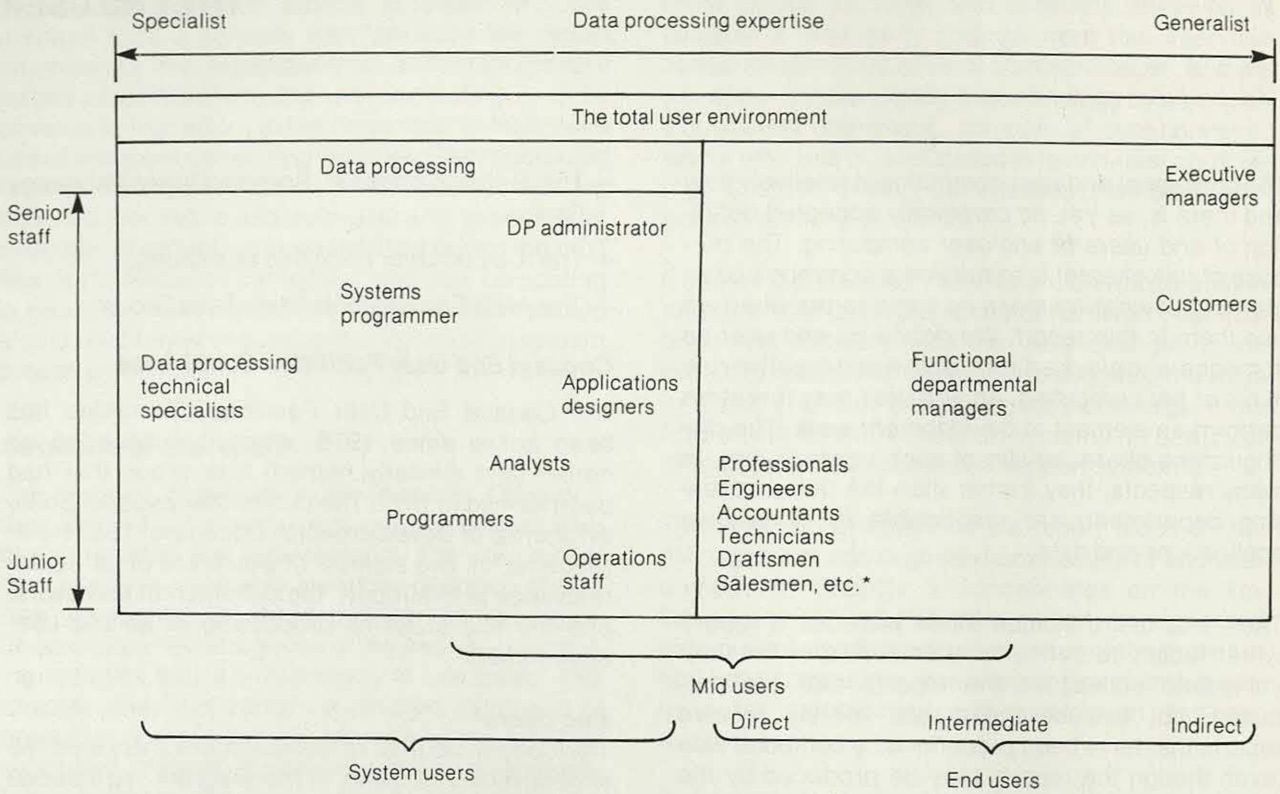
End users

The Codasyl Journal of Development illustrates the wide diversity of users in the diagram reproduced overleaf as figure 1. (This figure was borrowed by the Codasyl committee from the Share/Guide report listed as reference no. 2.) The figure shows that end users include a wide range of staff in terms both of their seniority and their data processing expertise. The range of expertise implies that the willingness of different types of staff to use equipment of any type directly (including computer terminals, typewriters and photocopiers) will also vary widely. In this report we are concerned with what the Codasyl committee defines as direct end users (see figure 1). The Journal of Development defines a direct end user as "functional professionals . . . who directly interact with the computer in accomplishing their work".

Forms processing

The Codasyl End User Facilities Committee concluded that end users are accustomed to working at desks with 'information-bearing' documents called 'forms'. These 'forms' may be reports, worksheets, memoranda, or they may be the standard pro-formas used in offices by all types of business. The committee's emphasis on forms processing means that it perceives a close link between end-user computing and office automation. The other working groups (whose work we review below) did not perceive such a close link. We consider the implications of this particular aspect of the Codasyl End User Facilities Committee's work in chapter 4 when we discuss likely future developments in end-user computing.

Figure 1 Share's view of end users



*Note: Clerical end users are not defined as a separate end-user class and are, by definition, considered logical extensions of the function to which they are assigned.

(Source: Share/Guide Report — Data Processing in 1980-1985; A Study of Potential Limitations to Progress)

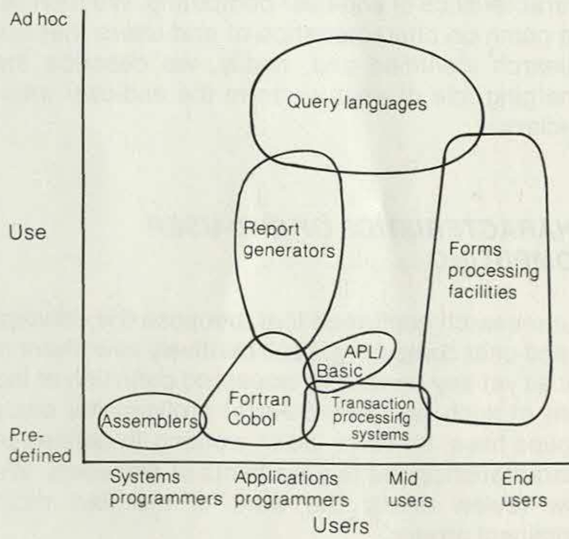
British Computer Society Query Language Group

The British Computer Society Query Language Group is a sub-group of the Information Retrieval Specialist Group and has been active since the late 1970s. In 1981 it published a report, *Query Languages — A unified approach* (reference no. 3). Figure 2, which is taken from that report, shows how various types of computing facilities are related to different types of users, depending on whether the facilities are used in an ad hoc or predefined manner.

The Query Language Group obviously concentrated on the use of report generators and query languages. One recommendation from the group is that suppliers of report generators and query languages should build facilities into their products that enable end users to define their own (perceived) records for extraction from corporate files. The implications of this aspect of the group's work are discussed further in chapter 4.

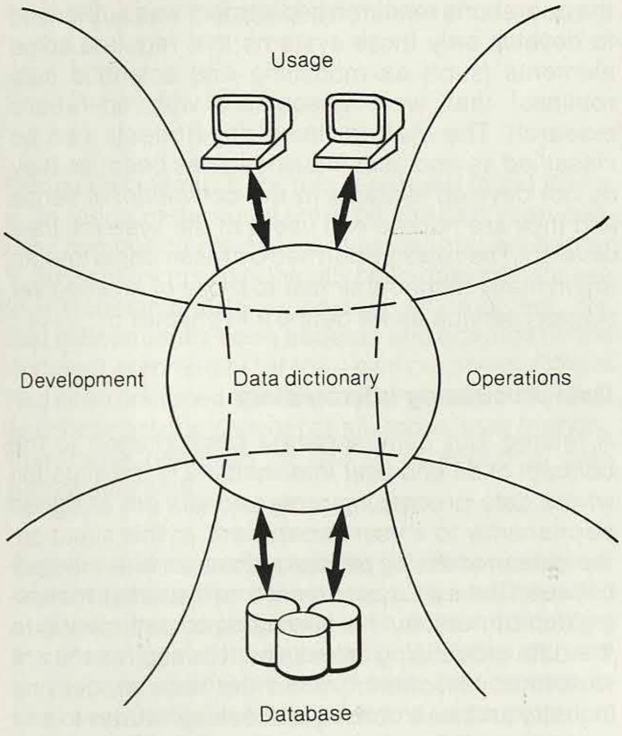
Early in 1982, the British Computer Society Query

Figure 2 Relationship between users and facilities



(Source: British Computer Society Query Language Group)

Figure 3 Complete user environment



(Source: ICL End User Facilities Sub-group)

Language Group was debating whether to widen the scope of its brief to include end-user facilities in general. In May of that year the group was reconstituted as the British Computer Society End User Systems Group.

ICL End User Facilities Sub-group

The ICL End User Facilities Sub-group is part of the Data Management User Group. It has been active since the late 1970s and has produced several reports. One report (reference no. 4) defines the way in which a conceptual view of data would be of use to end users. The key concepts contained in that report are encapsulated in figure 3, which illustrates the complete user environment as defined by the group. This environment is based on a data dictionary system, shown by the circle in the centre of the figure. The horizontal band represents the use of the dictionary for development activities, and the vertical band represents the access to computer files via the dictionary. Future developments arising from the work of the ICL End User Facilities Sub-group are discussed in chapter 4.

ANSI End User Facilities Task Group

The ANSI (American National Standards Institute) End User Facilities Task Group was established by the ANSI Data Base Systems Study Group. It was formed in 1981 and had met formally only a few times between then and early 1982. Although it is too soon for us to comment on the work of the task group, we believe that it is significant that the standards community is beginning to take an interest in end-user computing.

CHARACTERISTICS OF AN END USER

From our definition of end-user computing at the beginning of this chapter, it is clear that end users will vary widely both in their requirements and in their usage of computer systems. Nevertheless, most end users have certain common characteristics in their frequency and regularity of use, their training requirements, their job function and their role in the organisation.

Many end users are irregular users of computer systems. They may not use a terminal for several weeks or months, but may then use one in a concentrated way for several days at a time. Thus, at different periods of time, an end user may be either a regular and frequent user of computing facilities, or an irregular and infrequent user. Because of this unpredictable pattern of usage, most end users do not find it cost-effective to attend formal training courses. Instead, they prefer to try out the facilities (following a demonstration) and to refer to the user reference manual when they need assistance. The pattern of usage means also that an end user may not remember how to use a particular facility that was thoroughly familiar to him a few weeks earlier.

Our researches indicated that, in one area, end users differ markedly from data processing staff. That area is their attitude to applications maintenance. End users regard maintenance activities as a natural and meaningful part of their job. This attitude contrasts sharply with that of some data processing staff, who often regard maintenance as a necessary evil that is assigned to juniors or to staff with no further promotion potential.

The majority of end users encountered during our research can be classified as professional and managerial staff, such as accountants, economists, operations researchers, statisticians, actuaries, scientists, engineers, personnel managers, and so on. Most of them were employed at middle or junior management levels in staff functions at the head office rather than in local offices.

In some respects it is counter-productive to try to categorise the characteristics of an end user, because an individual's characteristics and role will vary depending on his immediate past. The same person can be at different times an expert user and then a novice user, and suppliers of end-user computing facilities should recognise that their products will be used by people with widely varying characteristics. Their products should therefore be flexible enough to cater for the needs both of experienced users and of novices. In particular, suppliers should ensure that experienced users can bypass the detailed and lengthy prompts and error messages that novice users require.

The wide-ranging and constantly changing characteristics of end users also have important implications for the corporate data processing function. Any end-user support service provided by the data processing function will need to provide varying levels of resources and support, including education and training.

END-USER INTERMEDIARY

The characteristics of end users that we set out in the previous section apply to end users in general. Our research, however, identified an intermediate type of end user who assumes the role of the local computing 'expert', and throughout the report we refer to such users as 'end-user intermediaries'. Other investigations have identified a similar role. For example, in reference no. 5 M. Trager talks of "the intermediary experts . . . specialists in using computer systems who are not actual users of the information obtained".

An end-user intermediary does not consider himself to be a data processing professional. Instead, he retains the functional job title (accountant, for example) of the user department, and his loyalty is to his profession and department rather than to data processing. Nevertheless, an end-user intermediary may spend between 30 per cent and 90 per cent of his time on data processing activities. Often he becomes the local expert and the first line of support for his colleagues in the user department. As a result, his immediate colleagues often will need to spend less time directly involved with end-user computing than they would otherwise.

The experiences recounted in chapter 3 of this report show that such end-user intermediaries can develop substantial data processing skills and expertise. Undoubtedly many of them could follow successful careers in data processing, but very few of them wish to do this. Their long-term objective is to become chief accountant, for example, rather than data processing manager.

Two of the organisations that we interviewed had formalised the end-user intermediary role within the operations research department. In each case the operations research department was carrying out significant systems development work for the user departments. In one instance the department was no longer called 'operations research', but had become the business systems unit within the data processing department. In the other organisation, the operations research department was authorised to develop only those systems that required some elements (such as modelling and scientific subroutines) that were associated with operations research. The staff in these departments can be classified as end-user intermediaries because they do not develop systems in the conventional sense and they are not the end users of the systems they develop. The roles performed by these departments are in many respects similar to those of an end-user support service as we define it in chapter 5.

Data processing intermediary

A related, but quite separate phenomenon to the concept of an end-user intermediary is the situation where data processing professionals are assigned permanently to a user department. In this situation, the data processing person acts as an intermediary between the user department and the data processing department, but his overriding commitment is to the data processing profession. His aspirations are to further his career within the data processing industry and, as a consequence, his attitudes to and perceptions of computing will be significantly different from those of an end-user intermediary as defined above. Nevertheless, a data processing intermediary identifies strongly with the user department to which he is assigned.

Our researches indicated that data processing intermediaries are less common than end-user intermediaries. Where data processing intermediaries do exist they use end-user facilities such as Fortran, APL or Basic, rather than Cobol.

SUMMARY

In this chapter we have attempted to define the terms 'end user' and 'end-user computing' as they will be used throughout the remainder of this report. The variety of end users is potentially very wide, although at present most end users can be classified as professional staff at middle management levels working in head offices. Such users initially are inexperienced and naive in their use of computing facilities, but some of them who use computers regularly and frequently can quickly become experienced or even expert users who may take on the role of end-user intermediary. Experienced end users soon become frustrated with the verbose prompts and error messages associated with end-user facilities designed for novice users.

In the next chapter we describe the facilities that our research showed were being used by end users. The facilities are at least as varied as are the end users.

CHAPTER 2

END-USER COMPUTING FACILITIES

During the research for this report we found that a wide range of products were being used in an end-user computing environment as defined in chapter 1. Some of them had originally been designed for use in a traditional data processing environment, but had subsequently been adopted and adapted by the end-user community for their own purposes. Others had been designed specifically for use by end users, and these products were usually more 'user friendly' than those designed for use by professional data processing staff.

In general, end-user computing facilities were provided on standard hardware products, and it was the software that distinguished end-user computing from traditional data processing. All types of hardware (from mainframe computers to microcomputers) were being used to provide end-user computing services, but we encountered only a few organisations that were basing their services on minicomputers. Where minicomputers were installed they were dedicated to a specific department, and the applications being run on them did not leave much spare capacity for end-user computing. In a mainframe-based environment, most end users accessed the facilities interactively via a visual display terminal, and most of them also had access to a hardcopy output device. In a few instances where bulky reports were required regularly and frequently, the end user had access to remote batch devices as well.

Most of the organisations that we interviewed had installed at least a few microcomputers, and a small number were using an intelligent microcomputer-based word processor as an occasional stand-alone microcomputer, or as a visual display terminal linked to a central mainframe. Some organisations allowed end users to acquire their own microcomputers without reference to the data processing department, but others acquired microcomputers only through the data processing department. A small proportion of the organisations had an explicit policy for acquiring and using microcomputers. For example, some organisations restricted the users' choice to a particular manufacturer or to microcomputers that could run the CP/M operating system, and one organisation encouraged the use of microcomputer packages and discouraged applications development by end users. All the organisations without an explicit policy for microcomputers believed that such a policy was desirable if not absolutely necessary.

The microcomputers or visual display terminals being used in an end-user environment were usually shared by several people. Those who had dedicated equipment tended to be end-user intermediaries.

Many of the software products are available for a wide range of hardware, but some are effective only on today's larger and more powerful (and therefore more expensive) computers. As the price/performance ratio of hardware continues to improve, many of these more sophisticated products will become available on less expensive hardware, and this trend can only accelerate the growth of end-user computing. One example of the changing relationship between hardware and software is videotex, where a combination of hardware and software has, in effect, created a new medium. In the future, videotex may evolve to become an end-user computing facility (particularly through the use of downloaded telesoftware). But at present most videotex systems are being used in a passive, predefined manner, and so they are excluded from the scope of this report.

Because it is the software that distinguishes end-user computing from traditional data processing, we now discuss the software aspects of end-user computing in more detail under the headings of:

—Report writers and query languages.

—System builders and programming languages.

—Decision support systems.

—Application packages.

—Executive software.

We do not provide a critical analysis either of the end-user computing facilities that are available or of the suppliers of the products, and we do not evaluate the relative merits of particular facilities. Our objective is to review a representative sample of the end-user facilities that are being used, rather than to provide a comprehensive catalogue of products and facilities. Thus, mention of a particular product or supplier is for illustrative purposes, and does not necessarily imply any endorsement. Similarly, an omission does not imply a condemnation.

REPORT WRITERS AND QUERY LANGUAGES

Report writers and query languages can be used by end users to retrieve information from established computer files. Such products are available from a wide variety of sources, including hardware and software suppliers, and user groups. Some organisations have developed their own in-house report writer or query language. We now summarise the features of report writers and query languages under the headings of file handling, definition of reports and enquiries, data dictionary features and user definition of data.

File handling

Some report writers or query languages work only with a proprietary file handler or database management system. For example, Univac's QLP has to be used in conjunction with the DMS 1100 database management system. Other products work with conventional files (for example, Filetab), or with several different database management systems (Informatics Mark IV, for example). Those products that have to be used in conjunction with a specific file handler are often provided with features that allow data to be extracted from other types of files. One example is IBM's SQL/DS, which provides utilities that enable data to be extracted from VSAM, DL1 and APL files.

Definition of reports and enquiries

Many report writers and query languages operate only in an interactive on-line mode, whilst others operate only in a batch or background mode. Increasingly, however, suppliers are providing such packages with both an on-line and a batch mode of operation. Some packages require the user to define his reports and enquiries through a command language. Such an approach, which is based on keywords and the use of an operator/operand-based language with syntactic rules, is preferred by end-user intermediaries because it enables them to interact directly with the system. Other packages help the user to define his or her reports and enquiries through a series of prompts. This type of approach is ideal for novices or for irregular and infrequent users, but experienced users find the prompts to be tedious. Alternatively, users may define their reports and enquiries by selecting items from a menu or by filling in forms. The menu or forms can be either in a paper form or displayed on a screen. Using menus or forms provides users with an extremely simple way of defining their requirements, but the procedure required for defining complicated enquiries or layouts can be cumbersome.

ICL's Reportmaster package allows the user to define his or her requirements through a language that is entirely non-procedural (that is, it does not contain statements of the 'If... Else' or 'Go to' or 'Do loop' type). The language is used to construct 'programs' that are used both to retrieve information and perform logical operations on it. Because of the non-procedural nature of the language, the 'programs' are extremely compact, and they are not necessarily run in the sequence in which the statements were written by the user. Reportmaster is intended for use both by data processing staff and by end users. We believe that the full range of facilities provided by the package should make it an extremely powerful and productive tool when it is used by data processing staff and by end-user intermediaries. Only the simpler subsets of Reportmaster are likely to be used directly by end users, however.

Many suppliers of report writers and query languages now recognise that their packages will be used both by data processing staff and by end users, and that these two categories of users have very different levels of expertise. As a result, some suppliers now provide their packages with a choice of modes for defining reports and enquiries, and with different levels of 'help' facility that the user can select to match his own level of expertise.

Some of the more sophisticated packages provide a 'run' or a 'macro' option that permits the user to predefine frequently used sequences of commands. When these sequences are subsequently used, only the variable parameters need be specified, and the 'macro' is processed in a batch or background mode. These options are typically used by the end-user intermediary or by the end-user support service on behalf of the end user.

Data dictionary features

The more modern and advanced report writers and query languages are based on the use of a data dictionary. The data dictionary often forms an integral part of the package, but may also be marketed as a stand-alone product (in which case it can be used separately from the report writer or query language). One example is ICL's data dictionary product, DDS, which is the basis for ICL's Reportmaster and Querymaster packages but which is also available as a stand-alone product.

The main advantage of a data dictionary in an end-user environment is that, once the principal databases and files have been defined by the data processing department and the data dictionary has been established, the user then needs only to describe any changes to standard formats. If no changes are described, the standard formats (such as file names and field names for use as report headings) are retrieved automatically from the dictionary. A data dictionary therefore not only makes a report writer or query language easier to use but also reduces the user's scope for making errors.

User definition of data

Most report writers and query languages do not permit the user to create his own names for the subsets of data being retrieved, although some products implicitly provide such a facility. For example, Adabas's Natural product permits the retrieval statements to be referenced by a statement number, similar to the statement number used in a Fortran program. The ability to identify statements in this way enables users more easily to store and reuse the results of a particular retrieval. Nevertheless, an explicit method of identifying the subsets of data retrieved would provide a more direct and usable means of creating, maintaining and using a 'personal' database.

SYSTEM BUILDERS AND PROGRAMMING LANGUAGES

Our researches showed that an increasing number of end users are prepared to develop their own systems. The systems they develop often need to access a subset of the corporate files, and most organisations provide a mechanism for extracting the appropriate subset for the private use of end users. We did not find many organisations that permit end users to interact directly with the corporate files, even in a read-only mode. However, technical facilities such as IBM's RACF (resource access control facility) are designed to provide secure read-only access to corporate files. In this section we review the two main types of system development facilities used by end users — system builders and programming languages.

System builders

A system builder is a set of software tools for building a complete applications system. A system builder therefore provides facilities for validating input data, processing data (both logical and arithmetical operations), handling files, producing batch reports, defining interactive procedures and displaying data. Procedures for handling file and transaction recovery in the event of a failure may also be included in a system builder. Usually, a system builder uses a very high-level language that often makes extensive use of non-procedural statements for data retrieval. Most system builders provide what we would describe as pseudo-Fortran for logical and arithmetical processing. We now illustrate the power and the scope of system builders by describing briefly two typical products.

IBM's Data Mapping Program (DMP)

The DMP product is based on a modified version of the relational database technique developed at IBM by Ted Codd. In the original relational model, a relation associates n attributes together (known as an n-ary relation), whereas DMP is restricted to binary relations where just two attributes are associated by each relation. Thus an n-ary relation might associate an employee's name, works number, telephone extension, department code, etc. A binary relation might associate name and number, or name and telephone extension. Thus an n-ary relation can be expressed as $n(n-1) \div 2$ binary relations, although in practice not all of the binary relations are necessary to express an n-ary relation.

Because DMP is restricted to binary relations it is easier for end users to understand and use it. The disadvantage of binary-relation systems such as DMP is that a large number of relations are required for any practical system and, as a result, they are extremely inefficient for databases of any reasonable size. Such systems may be impractical for databases of 10 megabytes and above, depending on the relationships and the complexity of the databases.

Univac's Mapper product

The Mapper (maintenance, preparation and processing of executive reports) product is an interesting example of the types of facilities that are now being used by end users. (Reference No. 6 describes one example of the use being made of this product.) Mapper includes the following facilities:

- —Self-contained demonstration of the main facilities.
- —Self-teaching aids that lead a novice through the main facilities and some of the options.
- —Comprehensive help facilities that are structured for use by people with different levels of expertise. At the most detailed level Mapper makes more information available through the 'help' screens than is contained in the user manual.
- —The ability to designate one terminal as the co-ordinator's terminal. This terminal can then be used to control the way in which all users access Mapper (for example, by specifying access restrictions, privacy codes, etc.). The co-ordinator's terminal can also be used to designate some users as novices, and any error messages generated by novice users would automatically be displayed at the co-ordinator's terminal. The co-ordinator can then take appropriate action, ranging from ignoring the message and allowing the user to solve his own problems, to telephoning the user to offer immediate advice. Judicious use of the co-ordinator facility can vastly improve end users' satisfaction both with the system and with the end-user support service.

Programming languages

Our researches showed that the most frequently used programming languages in the end-user environment were Basic and APL, followed by Fortran. A few organisations had recently begun to use Pascal, and all of these were using Pascal on microcomputers.

Many organisations discouraged end users from writing their own programs, and some organisations particularly discouraged the use of the Basic language. Several organisations, however, encouraged end users to write programs in APL. In its basic form, APL is not an easy language to learn, and casual users find difficulty in remembering how to use the language. But many suppliers have provided additional 'front ends' to APL in order to make it easier to use the language. For example, IBM provides ADRS (APL departmental reporting system) and ADI (APL data interface for interactive work). Both these products extend the capability and usability of APL. Another aspect of APL that needs to be considered is the relatively high computing power and main memory that it requires.

DECISION SUPPORT SYSTEMS

Decision support systems have been defined as "A concept of the application of interactive techniques to management decision making through tools that address unstructured rather than structured tasks; support rather than replace judgement; focus on effectiveness rather than efficiency". (See reference no. 7.) The term 'decision support systems' was introduced originally in 1971, and was comprehensively discussed in the ACM literature in 1980 (reference no. 8).

In the context of this report, decision support systems describe a set of software facilities that enable an end user to access readily corporate data, to generate and maintain his own data and to move data from one source (and format) to another. Decision support systems therefore enable an end user to manipulate data so as to utilise the most appropriate applications packages (for example, mathematical, statistical or modelling packages) and to present the information in the most appropriate form through the use of reporting or graphics packages. (We discuss in chapter 4 the way in which end-user computing facilities and decision support facilities are likely to converge in the future.)

At the present time most of the practical decision support systems exist in academic or research environments, although there have been some tentative experiments by commercial organisations (see reference no. 9). During research for this report we found one member organisation using Mathematica's Ramis product as a decision support system. This organisation was using Ramis to predict and anticipate major changes in customer service demands and thereby make intelligent recommendations for changing the level and the nature of the facilities provided.

The Ramis product provides report writer and query language facilities and it has its own file handler. Nevertheless, it can access data stored on the most commonly used IBM-based database management systems (DL/1, Total, IDMS and Adabas), and it can also access VSAM files. In addition, it has its own data dictionary system. Ramis is capable of formatting data in very complex ways as specified by the end user, although end users usually require some assistance from data processing staff in specifying the most complicated formats. The formatting capabilities of Ramis allow it to be used for passing data from package to package. Ramis also provides a limited graphic output, which is an extremely useful feature for including the results of complex processing in management reports.

APPLICATION PACKAGES

Our definition of end-user computing excludes the most common use of application packages, where a package is used in a passive, predefined manner. We did encounter a few end users, however, who were using a report writer or a query language to manipulate data produced by an application package. We also came across a few end users who, over a period, had modified a standard application package to suit their own particular requirements. In one instance, only the central algorithm of a package remained in use. The rest of the package had been re-written by the end user rather than by data processing staff. The implications of permitting end users to make such extensive modifications to packages are examined in chapter 5.

Most of the packages being used creatively by end users were mathematical, statistical or modelling ones. Many of these packages were originally available only at an external bureau but, increasingly, bureau companies are making their more popular packages available for in-house installation. This trend is a reflection of the steady drift of end users from external bureaux to large in-house installations. It also reflects the desire of many end users to be in control of their computing facilities.

EXECUTIVE SOFTWARE

Although executive software (such as transaction processing monitors, timesharing executives, operating systems, etc.) is not strictly an end-user facility, it is nevertheless relevant to this report. Most end-user software has to operate in conjunction with executive software and has to rely on such software for some of the end-user facilities. It is not possible to shield the end-user completely from the executive software, and end users will need to be aware of the relevant aspects of such software.

We found that end users were, in general, quite happy with the end-user product itself, but that every so often the end user had to interact with the executive software (for example, to initiate a file sort program or in the event of a failure condition). On those occasions end users did not find it easy to interact with the executive software, for two main reasons. First, they found the executive software to be much less 'user friendly' than the end-user product. (Some end users described executive software as being 'user hostile'.) Second, the language or commands used by the executive software were invariably incompatible with those required by the end-user product. For example, one might require the term 'log-off' to signify the end of a session, whilst the other might require the term 'stop'.

SUMMARY

In this chapter we have reviewed the types of products (hardware and software) that are being used in the end-user computing environment. Some of the products have been designed specifically for end users, but many were designed originally for use in a traditional data processing environment and have since been adopted by end users. Such products have not necessarily been updated to meet the different requirements of end-user computing. The past performance of a product as a data processing tool does not necessarily indicate its performance as an end-user facility, and each product should be evaluated in the light of its intended use.

Similarly, a successful supplier of data processing facilities may not necessarily be a successful supplier of end-user computing facilities. End users should be aware that the supplier who offers the apparently least expensive microcomputers or terminals or packages is often the one who has yet to establish a customer base and a reputation in the marketplace.

CHAPTER 3

END-USER EXPERIENCES

Our research into the experience of end users was carried out by interviewing representatives from organisations in a wide range of industry sectors about their use of the facilities described in chapter 2. We interviewed representatives from a total of 27 organisations, most of whom were members of the Foundation. Interviews were carried out in France, Italy, the Netherlands, Scandinavia and the United Kingdom. The interview findings were supplemented by a questionnaire survey that was sent to all Foundation members, 39 of whom returned completed questionnaires. Some of these 39 were organisations that had already been interviewed, so that our research findings are based on interviews with, or information supplied by, a total of 50 different organisations. Figure 4 analyses the organisations by industry sector, by whether they were interviewed or responded to the questionnaire, and by the number and type of staff interviewed.

In total, 53 people were interviewed. About half of these were data processing personnel and half were end users. Twelve of the end users were performing an end-user intermediary role as defined in chapter 1. Inevitably, the organisations who participated in the research were large organisations who were relatively active in the field of end-user computing. Also, most of the end users interviewed were nominated by the data processing department, and they were therefore likely to have been the more active and successful users of end-user computing facilities. Nevertheless, we believe that our research identified many useful experiences that are of general interest. In this chapter we now discuss the experiences of end users under the headings of end-user applications, end-user computing facilities and suppliers, end-user education and training, and organisation and management. The key issues arising from our findings are set out in chapter 5.

Figure 4 Summary of research into end-user experiences

Industry sector	Organisations researched				People interviewed	
	Interview			Total	Data processing	End users
		Questionnaire				
Public administration	1	2	1	4	3	3
Banking	2	3	3	8	5	5
Insurance	1	2	1	4	3	3
Retailing	—	1	2	3	2	1
Food & drink	1	4	3	8	4	3
Manufacturing	1	1	2	4	2	2
Chemicals	—	1	—	1	1	2
Energy & oil	1	2	2	5	2	3
Construction	1	—	1	2	2	1
Electronics & communications	3	—	3	6	2	4
Travel & leisure	—	—	3	3	—	—
Other	—	—	2	2	—	—
Total	11	16	23	50	26	27

END-USER APPLICATIONS

Most of the organisations that were interviewed or that responded to the questionnaire described end-user applications that had been operational for at least a year (and in some instances as much as five years). Our research showed that end-user applications cover a broad range of business functions, but for the purposes of this report we have classified them as:

- —Once-off applications.
- —Planning and management information applications.
- —Operational applications.
- —Applications that interface with corporate data files.

Once-off applications

More than half of the end-user applications described to us could be classified as once-off applications, although they accounted for a smaller proportion in terms of cost and effort. Typical examples were simple calculation programs developed by end users using VisiCalc, and more complex once-off procedures involving economic or statistical models. Such applications tended to be used a few times and then either discarded or modified beyond recognition. As a result, once-off applications did not lead to any significant maintenance workload.

Most of the once-off applications reported to us were typically developed in an ad hoc manner to replace a complex manual procedure which often required equally complex desk calculator procedures. In most instances, the applications had been developed quickly to meet a specific need. In the few instances where the application had to be modified substantially, the changes were due more to a lack of initial planning and foresight than to unpredictable changes in the nature of the application itself.

Planning and management information applications

In terms of cost and effort, the bulk of the end-user applications could be classified as planning and management information applications. A typical application was one developed by an accounts department to provide monthly financial analyses for management.

Many of the end-user planning and management information applications were based on the use of mathematical and statistical packages. As well as being used for modelling and simulation purposes, such packages were being used by end users to produce forecasts and management information. Some of the applications operated as stand-alone systems, but others required access to corporate files. (We describe this type of application in the section beginning on page 13.)

Most planning and management information applications written by end users were based on a report writer or a query language or a modelling package, although in a few instances a programming language had been used. We have already mentioned that one organisation was using Ramis for a decision support system.

Some of the applications developed by end users were remarkably complex. For example, in one organisation the personnel department had developed their own system to predict the effects of proposed changes in the company's compensation policy. The system was developed on a PDP 11/70 using a system builder called ADMINS/11. Although a small number of data processing staff provided an end-user support service, the bulk of the development work was carried out by a senior personnel manager (who performed the role of end-user intermediary). The application analysed and assessed a new personnel compensation package that included company cars, season ticket loans, insurances, pensions, etc. The application also provided administrative support for implementing the compensation package. Thus the application started life as a planning application, but evolved to become an operational application as far as the personnel department was concerned.

Another interesting facet of this example is the use that the personnel manager made of a Digital Equipment word processor. All printed output from the system was produced on the word processor, and the personnel manager used the word processor both to produce all of the user manuals and as a visual display terminal to access information held on the PDP 11/70. Because of the increasing workload generated on the PDP 11/70 by these end-user applications, it seemed likely that the PDP 11/70 would soon be replaced by a more powerful VAX 11/780. Fortunately, the ADMINS package is available also on the VAX computer.

The above example illustrates the way in which end users can successfully develop and operate their own planning and management information applications. However, we also encountered another example where a minicomputer system had been justified and installed in an end-user environment on the assumption that the user management would make extensive use of simple enquiry and report programs to extract management information. In practice, these facilities have not been used, and the user managers have continued to use manual methods for collecting information that, with a little effort, they could have extracted from the system.

Operational applications

Applications in this category include those that form an integral part of the day-to-day procedures of an operational function in the organisation. Thus operational applications are used in a production environment, or for customer service applications, or in the sales or accounting functions. In most respects, there is little (or no) functional difference between this type of end-user application and equivalent applications developed and operated by the data processing department. About a quarter of the end-user applications discussed in detail with the interviewees could be classified as operational applications. Like the compensation planning application described earlier, these applications were remarkably complex, ranging between the equivalent of 10,000 and 35,000 Fortran statements.

We now review briefly six of the operational applications that were described to us. The design, development and maintenance of each of these six applications was carried out not by professional data processing staff, but by end users or end-user intermediaries (although in some instances the users were aided by an external software house). Each of the applications was successful, and the originators could demonstrate quantified benefits well in excess of the costs of developing and running the applications. The users or the end-user intermediaries who developed the applications, and their colleagues who now use the systems, are well-satisfied with the facilities provided.

1. Production scheduling application

This application is used to schedule the production workload in a factory. The application was implemented originally about five years ago using a standard application package running on a Prime computer. Since then the package has been virtually rewritten by a production engineer and his assistant, so that only the main algorithm now remains intact. With the aid of one of the programmers who developed the original package (and who now works on a part-time freelance basis) the two engineers have written about 35,000 lines of Fortran. Whilst the package was being rewritten the engineers were, for some periods, spending all of their time working as system developers. They now spend about 20 per cent of their time maintaining the application, and they regard this task as an integral part of their jobs as production engineers, and not as a chore. This application is now being used by other divisions within the organisation.

2. Management accounting applications
The management accountant at a particular site has developed a set of management accounting applications that are now used for well over half of the accounting functions at the site. During a four-year period he has written about 25,000 lines of Basic, using a Call/VSPC service. His computing workload peaked when it occupied about 75 to 80 per cent of his time, but it is now down to about 25 per cent. He has recently proposed additional applications which, if approved, would increase his computing workload to about 50 per cent of his time.

Maintaining the applications occupies a surprisingly small amount of his time (between five and 10 per cent). This low level is due to the excellent design of the applications. Before embarking on the design the management accountant read some of the standard text books on system design and, as a result, he practises top-down structured design. He has subdivided his systems into a large number of small subsystems that are modular and fully parameterised, with all of the anticipated variables specified in tables rather than being embedded in the programs. In many respects, this end user has managed to turn the Basic language into a pseudo block-structured language.

Because of the financial nature of these applications, the internal audit department was involved in the initial design of the systems and in subsequently monitoring them.

3. Actuarial application
In one of the insurance companies in our interview survey, the actuary is working with two programmers from an external software house to convert an application from Fortran to APL. The application is used to compute the actuarial values of existing policies and to forecast the necessary levels of premiums for new policies. At present the application runs on an external bureau, but the actuary is converting it to run on an in-house APL service. This particular system is an integral part of the operations and management of the company, using data extracted from the corporate files.

4. Manpower accounting and charging application
Over a two-and-a-half year period, two engineers have devoted most of their time to developing a system (using the Ramis package) to account for and charge out manpower. The system now has a database of 200 megabytes and consists of 10,000 Ramis instructions. (Because Ramis uses a higher-level language than Cobol or Fortran, it is not easy to estimate what this represents in terms of Cobol or Fortran, but it is probably the equivalent of between 25,000 and 50,000 Cobol or Fortran statements.) The requirements of the application do not change very much and, as a result, the engineers now spend only about ten per cent of their time on maintaining the system. The system is used by 24 'real' end users. Because the application deals with money, the internal audit department was involved both during the design of the system and in its subsequent implementation.

5. Funds placement and loans financing application
Two operations researchers have used Logica's Rapport product to write about 10,000 lines of Fortran over a two year period for a system that is used for both long-term and short-term financing. Rapport is a relational database system that provides easy-to-use file handling facilities for small to medium-sized databases. It also has an enquiry language, IQL. Although the operations research department (rather than the user department) developed this particular application, the staff concerned exhibited almost all of the characteristics of end-user intermediaries identified in chapter 1.

6. Project progressing application
This application was developed by a project engineer, who devoted about 80 to 90 per cent of his time to developing the system over a period of six months. The system was written using the Mapper product (which we described on page 7) mainly by using Mapper's non-procedural facilities, although some pseudo-Fortran was also written to perform various calculations and to trigger various subprograms. The application is used by construction project engineers to ensure that all the resources required for large construction projects are in the right place at the right time. The application provides the engineers with facilities for project control and progressing, cost control, control of contractors' changes and maintenance of project documentation (including plant items and engineering drawings).

The project engineer who developed the system did not seek (nor did he require) advice from the company's data processing department.

Less-successful end-user operational applications
The six end-user operational applications described above were all successful but, from a traditional

data processing standpoint, their success could be judged as being due more to luck than to judgement. We were told also of two end-user operational applications that were less than successful, and these two examples illustrate some of the potential problems.

The first example concerns a production manager who had gained some superficial experience with his own personal microcomputer (a Sinclair ZX81). As a result of this experience he decided to acquire a Tandy microcomputer to automate his production load planning. His original intention was to develop the complete system himself. After a short time, however, he decided to use the services of a consultant, who spent about two weeks defining the outline of the system. One year later, the programs were still not completed. Most of the problem was caused by the over-ambitious objectives of the production manager. In addition, he could devote only a few hours a week to program development.

The second example concerns a microcomputer-based package that was acquired by an end user for a vehicle fleet management application. Although the specification of the package matched the requirements, the package was still not fully in operation many months after it had been acquired. The would-be end user had not taken into account the amount of data that needed to be converted. Nor had he considered the practicality of using data that had been recorded on greasy and barely readable forms and index cards in the vehicle maintenance depots. As a result, only part of the required data has been transferred to the microcomputer and because of this the application is of very limited use.

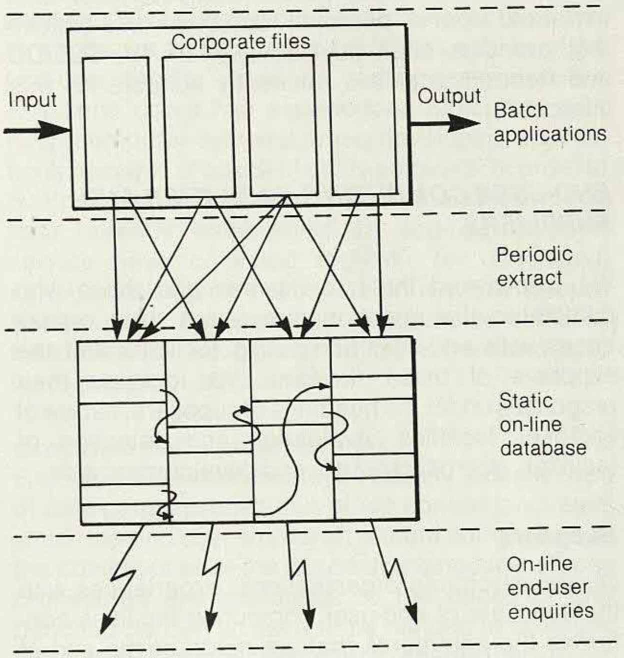
Applications that interface with corporate data files

Just over a third of the 50 organisations included in our survey described end-user applications that interfaced with corporate data files. All of the examples were of end-user applications requiring access to corporate information; there was no example of an end-user application that needed to update corporate files. The applications spanned all three types of end-user applications described above (once-off applications, planning and management information applications and operational applications). Examples were:

— A once-off retailing application that was used to answer questions concerning the performance of individual stores in selling particular products.

— A planning application in a bank, where a regularly run model is used to simulate the behaviour of different types of accounts in response to varying interest rates and withdrawal conditions.

Figure 5 On-line database extracted from batch files



— An operational application that aggregates all new and previously written insurance policies. (This application provides input to the actuarial application described earlier.)

Some of the organisations that extracted information from corporate files for use in end-user applications had needed to develop special extraction procedures to overcome the constraints imposed by their existing data processing applications. For example, one organisation had a large number of batch systems which used very large files. The combination of batch applications and large files was adequate for the purposes for which they were designed, but end users wished to extract and use information both in an on-line mode and as a corporate database rather than as segmented files. Figure 5 illustrates the way in which the corporate data processing department overcame these difficulties so that an on-line database could, in effect, be extracted and created from batch files.

The data processing department used the Adabas product to design and implement an 'extract-and-create-database' program that periodically produces a static database. End users then used the Natural language to access the database as if it was a live corporate database.

Some organisations had also found it necessary to create procedures that would combine subsets of corporate data with personal or departmental data maintained in a 'local' database. Our research disclosed a growing requirement for organisations to derive an 'end-user' database by merging data extracted from the corporate database with data extracted from a 'personal' database. We believe that products such as Ramis, Mark IV, SQL/DS and Reportmaster are eminently suitable for this purpose.

END-USER COMPUTING FACILITIES AND SUPPLIERS

We also asked the interviewees and those who completed the questionnaire about their experiences with end-user computing facilities and the suppliers of those facilities. We discuss their responses under the headings of suppliers, nature of end-user facilities, evaluation and selection of facilities, microcomputers and development aids.

Suppliers

Our research into organisations' experiences with the suppliers of end-user computing facilities confirmed the comments that we made at the end of chapter 2. Many of the suppliers who are aiming their products at the emerging end-user computing market are very small companies that have only recently entered the market. Some of them will undoubtedly be successful, but many will fall by the wayside, either being taken over or going out of business. The overriding lesson to emerge from our research was that organisations must select their suppliers of end-user facilities with as much care as they devote to selecting suppliers of traditional data processing equipment.

As an illustration of the potential pitfalls, the production scheduling application discussed earlier in this chapter was acquired as a package from a very small firm. Soon after the package was purchased, the firm that supplied it was disbanded. Fortunately for the purchaser, the programmer who had been mainly responsible for developing the package became a freelance programmer, and he was contracted to maintain and enhance the package.

Many of the organisations included in our interview and questionnaire survey said that they were dissatisfied with the level of end-user support provided by the suppliers. It is unreasonable to expect extensive end-user support to be available from the supplier of a microcomputer software package costing only a few hundred dollars. But several of the interviewees said that, even with products costing tens of thousands of dollars, the supplier continues to treat the data processing department (rather than the end users) as the customer. This attitude can be explained partially by the geographic spread of end users, but it is probably due also to most suppliers not appreciating the change in the nature of their customer base. The exceptions were computer bureaux, who in general had recognised that their real customers were the end users.

Nature of end-user facilities

More than half of the end-user computing facilities reviewed were designed specifically for end users. The remainder had been designed originally for use by data processing staff and had subsequently been adopted by end users. Facilities in this latter category were noticeably less 'user friendly' than products designed specifically for end users. But there was also a wide variation in the 'user-friendliness' of the specific end-user products. Very few of these products anticipated the widely varying levels of experience and expertise of the end users. For example, very few products provided different levels of interaction or error messages or help facilities to suit the different levels of experience and expertise of the users.

The user-friendly characteristics of the products were determined largely by whether a product was developed originally to use a full screen interactive visual display terminal or a keyboard/printer terminal or to operate in a batch mode. About a quarter of the products reviewed were developed originally to use a visual terminal, and in general these were easier to use than batch products or keyboard/printer products that had been converted to use a visual terminal. Approximately half of the products had been designed originally to use a keyboard/printer terminal. When these products were converted to use a screen they produced a ponderous line-by-line form of interaction.

Evaluation and selection of facilities

Our research showed that, in general, end users had not carried out a comparative evaluation and selection process before installing their end-user computing facilities. In many organisations the end-user products in use were already installed at a central computer or were on a preferred list of products. In several instances the product chosen had been the first that appeared to match the specific problem. If the end user had not explicitly specified the problem and the requirements, the likelihood of exactly matching a product to the problem was extremely small.

As an example, we were told of a depot manager who wanted to use a microcomputer to keep track of his stock records. He acquired a Tandy microcomputer without carrying out any sort of sizing exercise. As a result, the application almost worked, but it would have been really useful if the Tandy machine could have been upgraded. Unfortunately, the machine was the top model in the Tandy range, and the only way the depot manager could upgrade the hardware was by purchasing a second Tandy microcomputer or a more powerful machine from a different supplier. He would then have been confronted with the time and effort (and costs) necessary either to divide the application between two microcomputers or to convert the application to the new hardware.

Microcomputers

End users had access to microcomputers in nearly all of the organisations included in our survey. The number of microcomputers in the organisation ranged from a handful to more than 900 in one large organisation. Only about 20 per cent of the organisations sampled had a clear and explicit policy for acquiring and using microcomputers, and even amongst these organisations there was a wide variation in the policy guidelines. At one extreme, an organisation would permit end users to acquire a microcomputer from a prescribed list of suppliers (Apple, Pet, Tandy, etc.). At the other extreme, an organisation would specify that any microcomputer purchased must be able to run the CP/M operating system. One organisation had a fairly detailed policy for acquiring microcomputers, consisting of the following elements:

- All microcomputers must have a CP/M capability, so that applications and data can be exchanged freely between different devices.
- All microcomputers must be capable of being upgraded to at least 64k bytes of main store.
- All microcomputers must be able to have Winchester disc drives attached to them.
- All microcomputers must be capable of being linked to the central computer installation as a terminal so that they can access corporate files.
- Equipment not on the prescribed list must be explicitly approved by the data processing department. In this way, the department can prevent many different types of microcomputers proliferating throughout the organisation and can minimise the support problems.
- The data processing department must be informed of an intended purchase, regardless of the price of the microcomputer. In this way the organisation can take advantage of bulk discounts.
- All intended software purchases must be referred to the data processing department. This enables the department to advise the end users about the relative merits of different facilities (for example, VisiCalc versus Micro-Modeller).

Development aids

We noted in chapter 2 that it was not possible to shield end users completely from the executive system software and that, as a result, the usability of the end-user facility could be reduced significantly. Also, end users had experienced difficulties with microcomputer systems when developing applications because of a lack of utility software. In order to overcome these problems, those organisations that have already established an end-user support service have collected together (or developed) various development aids, which we now discuss briefly under the headings of executive software interfaces (or envelopes), utilities, front-end software and program libraries.

Executive software envelopes

Executive software envelopes usually took the form of catalogued procedures of job control languages which the end user employed without being aware of the complexities of the job control language. (These procedures are analogous to the decks of prepunched cards that used to be handed to scientific users by data processing staff to enable them to run their batch Fortran programs.) The envelopes simplify the task of selecting the appropriate optional facilities offered by the operating system.

Utilities

Apart from a few of the advanced system builders described in chapter 2, most end-user facilities required some additional supporting software utilities, such as sort routines, or routines to extract a sub-file from a corporate database. Such utilities were typically written (or tailored) by the end-user support service for use by end users.

Front-end software

Our research identified two types of front-end software that organisations have found necessary to attach to their end-user facilities — demonstration and teaching software, and software to improve the 'user friendly' characteristics of the facility. Both types of front-end software were designed to make the original facility easier to learn or easier to use.

One end-user support service had tried without success to persuade the supplier of a system builder to provide a demonstration/teaching front end to its product. Through a user group the support service discovered that other users of the system builder had identified the same need, and further research identified a user in the United States who had written such a package. As a result, the front-end package was acquired and is now used extensively among the particular system builder's users.

Many of the end-user facilities that we investigated provided only a single level of user interface in terms of the language used, error messages and help facilities. Some end-user support services have developed interface software for the more popular packages so that they now provide at least one novice level of interaction and one experienced level of interaction. Such software was usually written using the macro capability provided with the package.

In addition, some of the end-user facilities that were designed specifically for on-line interactive working did not provide a batch or background mode of working. But our research showed that, in an end-user environment, users are often happy to receive regular reports and printouts on a batch basis — once they have experimented with the on-line facilities to clarify their requirements. Some end-user support services have therefore provided a macro facility that could be used to group together a predefined sequence of on-line interactive commands. In this way, an on-line end-user facility either could be made to behave in the same manner as an on-line transaction processing application, or could be run as a batch or background job to produce bulky output.

Program libraries
Most end-user support services maintained a program library on behalf of the end-user community. A bulletin or newsletter often formed the vehicle for disseminating information both about the library and about other mutual self-help aids.

END-USER EDUCATION AND TRAINING

Only two of the organisations in our sample provided end users with systems training (such as training in logical thinking, project planning, systems and data analysis, documentation, etc.). Most organisations did not see a need for general systems training because most of their end users already had a scientific or numerate background. In addition, organisations did not see a need to provide general systems training to end users who they believed were only going to develop small and short-lived applications.

We believe that this may be a shortsighted attitude. The end-user applications described earlier in this chapter show that some end users are quite prepared to tackle large and complex operational applications. Such end users almost certainly began their computing experiences by developing once-off applications before graduating to large operational applications. If organisations do not provide the opportunity for general systems training at an early stage, then end users without any formal systems training could be developing operational systems that, potentially, have a huge impact on the organisation.

Just over half of the organisations, however, did supply some form of training in the use of the end-user facilities or products. About half of this group sent data processing staff and the initial group of end users on courses run by the supplier. The remainder ran in-house training courses, usually for subsequent groups of users of the product. About a quarter of the organisations surveyed said they relied on demonstrations followed by practical experience.

Some of the more commonly used end-user products (such as Basic and APL) have built-in self-teaching tools. We encountered organisations that had deliberately chosen microcomputer versions of Basic and APL with such self-teaching tools because they provided greater portability of software and also shielded the user from the executive software. Self-teaching tools reduce the cost of training enormously for large groups of end users. They also allow end users to learn at their own pace and at their own desk — or even perhaps at home if the tool is based on a microcomputer.

ORGANISATION AND MANAGEMENT

The organisations that participated in the research for this report provided us with information about the ways in which they organise and manage their end-user computing facilities. In this section of the report we discuss these aspects of end-user computing under the headings of policy and planning, management control, financial control and salary differentials.

End-user policy and planning

Almost all of the organisations that we interviewed or that responded to the questionnaire actively encouraged the development of end-user computing. Their estimates of their expenditure on end-user computing (as a percentage of the total data processing budget) varied between a fraction of one per cent to as much as ten per cent. Some organisations devoted part of the capacity of their central computer installations to use by end users. For example, a major partition of a large mainframe might be devoted to end-user computing, or sometimes a smaller mainframe (or a large minicomputer) dedicated to end-user computing might be installed at the central location. Dedicated hardware that we encountered during our research included IBM 4341s and a 370/168, ICL ME29s and DEC PDP 11s. In terms of computer workload, the percentage accounted for by end-user computing was as much as 25 per cent (or more) in those organisations that made very heavy use of end-user computing facilities.

The majority of the organisations in our survey believed that the use of end-user computing facilities will continue to grow. Significantly, only about half of these thought that the existing end-user facilities would be able to cope with the anticipated growth. Nearly all of the interviewees who believed that end-user computing would continue to grow said that the growth would be independent of the growth in traditional data processing activities. Only a few believed that the past growth in traditional data processing might slow down as a result of the faster growth in end-user computing.

Only about a third of the 50 organisations had any form of strategy for end-user computing and, of these, only a few had an explicit policy (or plan) for guiding, rather than controlling, end-user computing. Nearly all agreed that it would be very difficult to control end-user computing in the same way as traditional data processing.

More than half of the organisations surveyed had established some form of end-user support staff. The ratio of support staff to end users varied from 1:150 to 1:5. About a third of those who had established an end-user support service had at least one support staff for every ten end users. The support staff that we spoke to (and their managers) invariably had a constructive and helpful attitude towards their end users and played an active role in the development of end-user computing. Their attitude was not unlike that of a successful marketing-oriented computer bureau.

Some of the IBM users in our survey had established 'information centres' which perform the function of an end-user support service as we have defined it in this report.

In general, those organisations that had an end-user computing policy also had an information systems strategy that incorporated policies for centralised processing, distributed processing, communications, data management and, in some instances, office systems as well. These organisations tended to treat end-user computing as an element of the overall information systems strategy. In our view, there is no other approach.

Most of the organisations interviewed who had not already done so were considering establishing an end-user computing policy. In view of the current status of end-user computing and its anticipated growth there is an urgent need for such policies. In chapters 5 and 6 of this report we provide advice about how an end-user computing policy can be established.

Management control

About a third of the 50 organisations had produced some form of guidelines or standards for end users to follow when they were specifying or documenting their applications. A significant proportion of these organisations admitted that they had no way of enforcing the guidelines and standards, and they were unsure if end users were actually following them.

We were not surprised to discover that end users were quite happy to write their own user manuals and, often, these manuals were more readable than many of those produced by data processing staff. But, in general, end users had not produced detailed documentation of the type that would be required to maintain their systems in the absence of the original developer. In a few instances, end users had tried to hand over their applications to the data processing department for subsequent maintenance and enhancement. Such an application was usually rejected because the data processing department believed that the documentation was inadequate.

One of the conclusions of this report is that alternative end-user facilities should be evaluated before a purchase decision is made. To carry out such an evaluation it is necessary first to have a clear statement of the requirements of the systems that the facilities will be used for. Although many end users did make some attempt to write down their requirements, most of them produced only a single page synopsis of their requirements. The data processing department was involved in producing the end-user requirements specification in only about a quarter of the organisations surveyed.

About a quarter of the organisations had adopted a completely laissez-faire attitude to end-user computing, but several others had recognised that end-user applications can potentially put the organisation at risk. These risks might be caused by end-user applications processing financial transactions, or by sensitive information being accessed by unauthorised users through an insecure end-user application. Because of these risks, several organisations insisted that certain end-user applications should be vetted by the data processing or internal audit department. Such a vetting procedure has the additional advantage of providing an independent check on the validity of results produced by an end-user application.

About half of the organisations did not impose any restriction on the type of applications that end users could develop. But a quarter of the organisations imposed restrictions on the data that end users could extract from corporate files, and a quarter restricted the resources (computers, data processing, staff, terminals, etc.) that end users could acquire and use.

Financial control

More than 40 per cent of the organisations that responded to the questionnaire or that were interviewed had not set any financial limits to their expenditure on end-user computing. About 40 per cent of the organisations had set a limit to the overall expenditure, but they conceded that the limit was not easily enforced. The remainder of the organisations were imposing financial control by setting limits to the capital expenditure on hardware (mainly microcomputers and terminals) that could be incurred by end users.

Most of the organisations had some form of mechanism for charging end users for their computing facilities. This mechanism was usually based on an annual budget backed up by a usage-reporting scheme, although about a third of the organisations had a usage-based internal invoicing system.

Most of the end users that we interviewed were well aware of their hardware costs, and those who were charged for end-user services provided by a central installation were also aware of that element of their costs. The majority of the end users, however, had only a very approximate idea of the costs incurred in developing their systems, and they tended to ignore their own personal investment in the development process. In general, end-user applications cost less (and took less time) to develop than equivalent applications developed by data processing staff, but they cost more to run than the equivalent data processing applications. We discuss the implications of this finding in chapter 5 as one of the key issues of end-user computing.

The majority of the organisations made some attempt to cost-justify their end-user applications. In more than half of the organisations, the cost justification was carried out only by the end users, but in about a third of those surveyed the data processing department was involved as well. A few organisations subdivided the cost-justification exercise, with the data processing department working out the total costs (including development and running costs) and the user department estimating the benefits. The user department was then responsible for putting the case for proceeding with the application.

Salary differentials

In chapter 1 we identified the comparable (but distinct) roles performed by end-user intermediaries and by data processing staff who are allocated permanently to a user department. Our research showed that these two types of organisation can give rise to problems with salary differentials and career prospects. These problems manifested themselves as a slight feeling of unease amongst some of the data processing managers and end-user support service managers that we interviewed. For example, in one organisation an end-user intermediary who spent most of his time writing APL programs earned only about two-thirds of the salary of the data processing advisor who was assigned to his department. The advisor was much younger than the end-user intermediary and in fact had only a slightly superior knowledge of APL.

SUMMARY

In this chapter we have set out the results of our researches into end-user experiences. Some organisations may be surprised at the extent and sophistication of some of the applications and facilities that are now being developed and controlled by end users. The diversity of applications and of end users is indicative of the rapid growth in the phenomenon of end-user computing. Rapid growth, however, is inevitably accompanied by a variety of problems, as described in the later sections of the chapter. The user experience recounted in this chapter shows clearly that end-user computing is not a temporary phase. Organisations need to take account of end-user computng in their overall systems strategy planning. The last two chapters of this report respectively provide advice about the key issues arising from our research of end-user experiences, and advice about the establishment of an end-user support service.

CHAPTER 4

FUTURE DEVELOPMENTS IN END-USER COMPUTING

The experiences reported in the previous chapter show clearly that end-user computing is growing rapidly. But the phenomenon is relatively new and, as we emphasised in chapter 1, there is as yet no commonly accepted definition of the term. Before organisations can include end-user computing in their overall systems strategy planning, they therefore need to have some idea of the way in which it will develop in the next few years. In this chapter we predict the likely future developments in all aspects of end-user computing (facilities, applications, types of end user, etc.). Our predictions about the basic technology (software and hardware) are confined to a three-year horizon, because we believe that in such a rapidly changing field it is unrealistic to look further ahead than this. Human and organisational aspects of end-user computing will probably change less quickly, however, and our predictions in these areas may take up to seven years to fulfil.

The chapter is arranged in six sections, the first five of which respectively discuss the likely developments and changes in applications, in software, in hardware, in the profile of end users, and in the role of the management services (or data processing) department. The final section attempts to place the assimilation of end-user computing technology in context with earlier developments in computing and data processing.

APPLICATIONS

Although only about a quarter of the applications that we examined during the research for this report could be classified as operational ones, we believe that the most significant growth in end-user applications will occur in this area. The growth will be caused by several factors, including:

- The unrelenting pressures on the data processing department to maintain existing applications.
- The continuing demand for new applications that will arise from new ways of using existing data.
- The availability of more powerful system building tools.

Given these factors, we have every reason to believe that end users will be willing and able to develop a wider diversity of operational applications. Several information technology pundits (for example, reference no. 10) believe not only that this course of action is inevitable, but that organisations should be actively striving to hasten the process.

Operational end-user applications will, in the main, be developed by the type of user that we have described as an end-user intermediary. The majority of end users will use their computing facilities for personal information handling and for decision support. (See also the discussion about the future development of convergent facilities on page 22.)

SOFTWARE

The most significant developments in the nature of end-user computing will come from the development of software that is aimed specifically at end users. We discuss these changes under the four headings of user friendliness, product families, software interfaces, and data management.

User friendliness

As software suppliers realise that there is a huge potential market for their products among end users, software will become easier to use, and it will become easier to learn and remember how to use the facilities available. The growing market for (and availability of) user-friendly software aimed at end users has been comprehensively reported by EDP Analyser (see references nos. 11 to 16). In particular, the June 1981 issue of EDP Analyser contains a thorough review of software products that can be used to support end-user programming.

An example of the trend towards software that is easier to use is the recent introduction of the Cobol Animator product by Micro Focus. This product enables a user to execute a Cobol program one instruction at a time and to examine the interim results on a visual display terminal. Cobol Animator therefore provides a dynamic programming aid that has the potential to improve programming productivity by an order of magnitude. (Micro Focus also supplies CIS Cobol, which has become a de facto standard in the United States and Europe for microcomputer-based Cobol compilers.)

A further development in end-user software products will emerge as suppliers accept that their products will be used by end users with a wide range of computing experience and expertise. Suppliers will increasingly provide their products with different modes of interaction that are suitable for use by people with different levels of skill and experience. The modes will range from extremely verbose dialogues or hierarchically structured menu-driven systems to extremely terse and abbreviated commands. In addition, as suppliers realise that the same end user can at different times be an expert user or a novice, they will provide facilities for end users to dynamically change their mode of interaction.

Thus, end-user software products will increasingly offer multiple levels of user interaction. The end user can then select the level that is most appropriate at a particular time. The same concept of multiple levels of interaction will also apply to self-teaching tools and hierarchical 'help' facilities.

Product families

Suppliers of end-user software products will increasingly provide families of products with a wide range of capabilities for system building and decision support. Some end users will require only a particular subset (a query language or a report writer, for example). Others will use the complete family to develop and run their applications. The benefits of these integrated families of products will be twofold. The organisation will not have to acquire and support a variety of incompatible products, and the end users will not have to learn how to use a variety of incompatible languages and facilities.

Software interfaces

The experiences reported in chapter 3 showed that, in general, end users found their software products reasonably easy to use, but that difficulties were encountered when the product forced them to interact with the operating system or timesharing executive, or with other administrative software such as an end-user services package (VSPC, for example). The designers of each type of software have their own view of what constitutes an acceptable user dialogue, and the different views can create a very confusing situation. (As an extreme example, we witnessed an end user terminating a run by typing in succession 'stop' for the end-user package; 'end' for the end-user services package; 'quit' for the timesharing executive and 'logoff' for the operating system.) There is an obvious need for standardisation in this area, but we are not optimistic that any such standardisation will be achieved in the foreseeable future. Several suppliers are usually involved in providing the hierarchy of software described above and, even if there is only one supplier, the various software products would have been developed at different times and by different development groups.

One possible development that might help to alleviate this problem is the use of large visual display devices incorporating a split screen. With the appropriate supporting software, the end user could then retain the current dialogue in one part of the screen whilst using another part of the screen for a different purpose (for example, to access the data dictionary through the timesharing service).

Data management

Another development in end-user software will be the emergence of facilities that remove the need for an individual user to describe data that is shared by many users. Such facilities will be implemented through an on-line, dynamic and active data dictionary. The data dictionary could be the corporate dictionary if the organisation has implemented a data management strategy, or it could be the data dictionary provided as part of the end-user product. The description of the data, both in semantic terms and in terms of format, would be derived automatically from the context in which the data is used, although facilities would be provided for an end-user to redefine names and formats to suit a particular application. From the end user's point of view the data would be self describing. Developments such as these have been predicted both by the British Computer Society Query Language Group and by the ICL End User Facilities Sub-group.

Such data management facilities will enable end users to construct complex applications (such as decision support systems) with minimum assistance from the data processing department (see reference no. 9). When such facilities become widely available and are in general use, the benefits of 'management information systems' that were promised in the 1960s will finally begin to be realised.

HARDWARE

Developments in computer-based technology have been well documented in several previous Foundation reports and in papers presented at Foundation conferences. In this section of the report we focus on those aspects of hardware development that are likely to have an impact on the evolution of end-user computing — microcomputers and terminals, multifunction workstations, local area networks, office system products and what we term 'convergent facilities'.

Microcomputers and terminals

From the standpoint of end-user computing, the distinction between microcomputers and terminals will increasingly become less clear. More and more makes of microcomputer can now be linked to most ranges of minicomputers and mainframes, and more terminals can provide stand-alone 'personal' computing. (For example, ICL's DRS 20, which has a comprehensive range of software including the CP/M operating system, Basic, Cobol, etc.)

The proliferating choice of hardware for the end user means that it becomes ever more difficult to evaluate and select the most appropriate equipment. Organisations need to ensure that those responsible for evaluating and selecting end-user equipment (whether they be the end users themselves or data processing staff) have the necessary skills and expertise.

Multifunction workstations

A multifunction workstation is a single device that incorporates a display screen (usually able to display at least an A4-size document), a keyboard and alternative methods of controlling the display (lightpen, data tablet, pressure sensitive screen, roller ball 'mouse', etc.). It also provides facilities to manipulate data, text, graphics and perhaps voice information. Foundation Report No. 35 will examine in detail the development and use of multifunction equipment.

At the present time, multifunction workstations are expensive, but the continuing improvements in the price/performance ratio of microelectronic devices and the prospect of volume production will combine to reduce the price. We expect a volume market for such devices to begin to emerge when their price falls (in real terms) to about half of the current prices. Estimates of when this will occur vary between late 1983 and 1987.

We have already mentioned that we expect multifunction workstations (particularly those with split screens) to be an extremely attractive end-user computing tool. Although there are not, as yet, many commercially available products, a considerable amount of research work has been aimed at defining the requirements of such devices. For example, the Codasyl End User Facilities Committee (in its work on forms processing — see reference no. 2) has defined a set of 'data objects' and an 'object manipulation language'. Data objects are defined by terms such as 'binder', 'filing cabinet', 'folder', 'file', etc.

The Codasyl work has also defined the way in which 'data objects' will be located and, in this respect, it overlaps to some extent the 'electronic desk' concepts being explored at Queen Mary College, London (reference no. 17). The experiments at Queen Mary College are designed to model the behaviour of a white collar worker using an electronic desk. The 'desk' itself consists of a horizontal work surface incorporating an integral flat screen.

We now review the features of two commercially available products which, although not marketed as multifunction workstations, have the necessary components to be used as such. We believe that by mid-1985 both of these products will be viewed by the marketplace as multifunction workstations. By that time we expect that many similar products will have been launched by other suppliers.

Xerox 8010

The Xerox 8010 (also known as the Xerox Star) is currently marketed as an office tool for handling text-based documents. However, the 8010 provides a language called Cusp (customer programming) with which end users can develop their own applications. Cusp can be described as a 'programming by example' language because, in essence, it remembers what the user is doing, and can then repeat the particular series of operations. The 8010 also has a split screen that can simultaneously display two A4-sized documents. This facility allows multiple tasks to be handled concurrently.

The user software on the 8010 has been carefully designed to provide both a non-intimidating interface for novice users and an efficient interface for experienced users. The level of information provided by the user dialogue messages follows the 'need to know' principle. Thus the user can request additional messages that progressively disclose more detailed information. (A full description of the use of the Xerox 8010 can be found in reference no. 18.)

ICL PERQ

The ICL PERQ is currently marketed as a scientific and engineering workstation for use by professional staff. It comprises an A4-sized high-resolution graphics screen and up to 1M bytes of storage. Its powerful 16-bit microprocessor means that it can operate as a stand-alone device, but it can also be connected via a local area network to the corporate central computer and databases. At present the PERQ enables users to develop programs in the Pascal language, but ICL plans to make the Unix operating system and the Fortran language also available in the near future.

The Science and Engineering Research Council in the United Kingdom is examining the ways in which the PERQ can be used for office systems. Such a development could place the PERQ in exactly the same market segment as the Xerox 8010.

Local area networks

New local area network products are announced with monotonous regularity, and in Foundation Report No. 28 we reviewed the principal classes of products and the early experiences of using them. Local area networks are designed to interlink all types of computing devices. In the context of end-user computing they are particularly relevant because of their ability to link microcomputers or intelligent visual display terminals to file servers, print servers and (through gateways at voice or data exchanges) to central installations. Our view is that local area networking facilities will play an important role in the development of end-user computing because they will make available to end users a wide range of facilities. Significantly, both of the potential multifunction workstations described above have been designed for use with a local area network.

Office system products

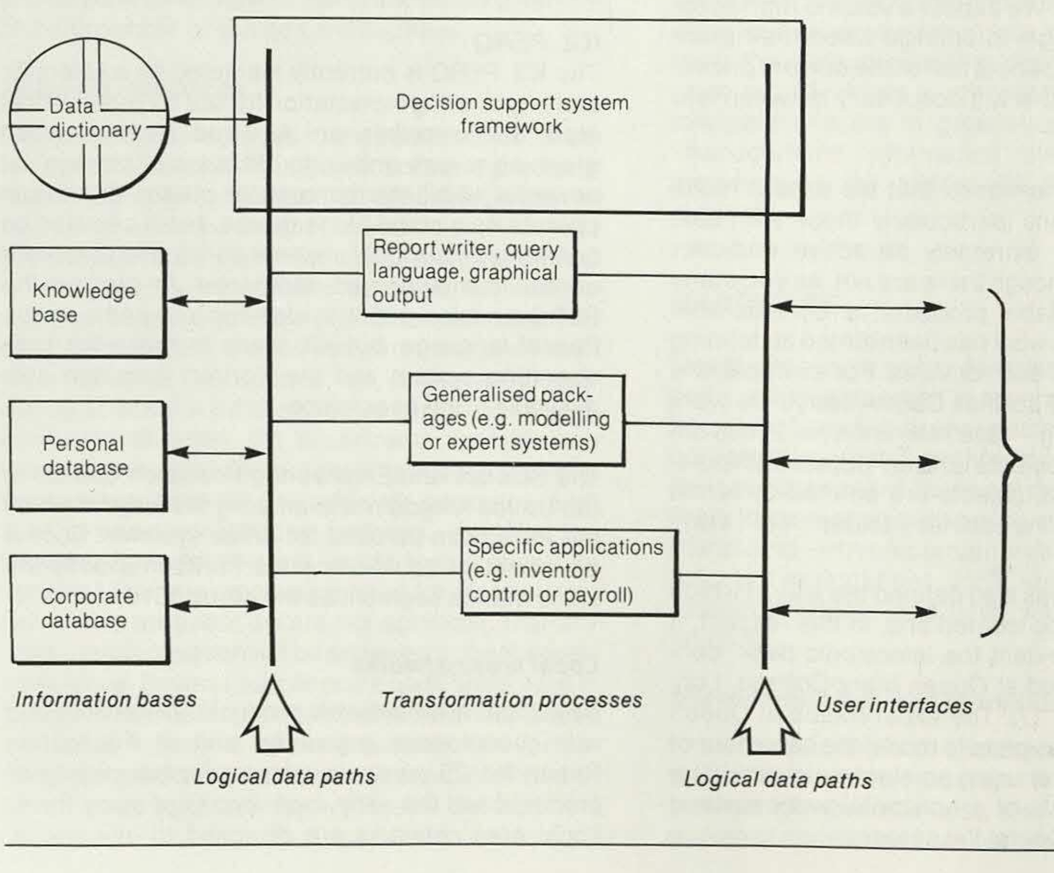
In Foundation Report No. 19 — Office Systems Strategy — we suggested that end-user computing (or personal computing) would play an important role in the development of office systems. In that report, and in Report No. 29 — Implementing Office Systems — we emphasised that the real benefits of computer-based office systems will come from their widespread use by managerial and professional staff. Such usage is much more likely to evolve from today's end-user computing than from today's word processing systems.

The conclusions of the earlier 'office systems' reports were substantiated by the research carried out for this report. Few of the end users who were questioned for this report felt a strong need for word processing (with the notable exception of one personnel manager). But many of them expressed the need for electronic messaging so that they could transmit automatically the results of their own processing to their colleagues, who might be in the same building or at a different location.

Convergent facilities

Although we have described separately the trends in end-user applications, in software and in hardware, it will be less easy in the future to distinguish between these elements. One possible scenario for the development of convergent facilities that incorporate the types of applications, software and hardware that we have described is given in reference no. 19. The authors of that paper (Gutz, Speir and Wasserman) predict an increase in the use of 'expert systems', which will be built on today's database technology and the growing theoretical understanding of 'knowledge engineering'. Thus database technology will be used to construct a knowledge base that can be used by professional and managerial end users to support their decision making. Figure 6 illustrates in schematic form a possible structure for such a decision support system framework.

Figure 6 Structure for a decision support system framework



The structure has four main elements:

— User interfaces, such as keyboards, handwriting devices, voice input and output devices, screens, printers, graphical devices, etc.

— Information bases, such as corporate and personal databases, a 'knowledge base' for use with expert systems, and a data dictionary whose contents describe all the other data.

— Transformation processes that link the user interfaces and data interfaces. These processes include report writer or query language facilities for extracting data, and more complex transformation facilities available with mathematical, statistical or modelling packages. They also include heuristic and inference processes for transforming information through expert systems, and predefined processes for transforming information through specific applications.

— Logical data paths that are used to move information between the interfaces and the processes. Note that the results of a particular transformation process need not pass directly to the user interface, but could be fed automatically into another transformation process.

The underlying premise of such a decision support structure is that, in order to solve a particular business problem, the end user needs to access and process information that is stored in a machine-readable form. The purpose of a decision support system is to transform data from a less understandable state to a more meaningful and usable form. We believe that the framework illustrated in figure 6 provides the basic mechanism for carrying out such transformations. Before these mechanisms can be really effective, however, easy-to-use 'natural language' command and control languages need to be developed. Much current research is aimed at specifying the requirements of such a language, and some of the more sophisticated query languages and expert systems now available provide pointers to the way in which such languages will develop. But providing a truly easy-to-use free-format language requires enormous computing capacity in order to translate unstructured (and perhaps ambiguous) requests into logical instructions that can be understood by the system. The continually improving price/performance ratio for microelectronic devices is bound, in time, to remove this constraint.

The end-user interface with such a decision support framework will be a multifunction workstation through which text, voice and graphics can be freely combined with data. The workstation will require considerable storage capacity — about one megabyte of main storage and perhaps up to about 40 megabytes of on-line backing storage that would be used for interchanging programs and data between the different elements of the decision support system. Equipment with these physical characteristics and with software suitable for use by end users should be available by the mid-1980s at prices between $10,000 and $20,000.

END-USER PROFILE

Our research has shown that the majority of the present end-user population is drawn from staff functions and from technical or professional functions. We believe that the developments in applications, software and hardware described earlier in this chapter will widen the end-user population. In particular, lower and middle managers will make increasing use of end-user computing facilities because of the increasing use of decision support systems. Senior administrative staff and supervisors will also make increasing use of the facilities because of the evolution of office systems.

Although we expect end-user computing to evolve rapidly, its growth will be evolutionary rather than revolutionary. In particular, as today's generation of students join the workforce and later take up their first management roles, the fear of the unknown will disappear. Many European countries have plans to equip every school with at least one microprocessor. As a result, in five years' time a computer terminal or microprocessor will be as familiar to the average young person as hi-fi equipment or the telephone is today.

One consequence of the increasing pervasiveness of end-user computing will be that end users' expectations also will increase. Suppliers of end-user computing facilities (software and hardware) will need to devote much effort to the design of their products in order to meet those increased expectations.

FUTURE ROLE OF THE DATA PROCESSING DEPARTMENT

One consequence of the increasing extent of end-user computing is that the data processing department may find that its traditional applications maintenance workload will decrease. This has certainly been the experience of IBM Canada (reported in reference no. 16). IBM Canada claims that, as a direct result of end users performing more of their own computing, the data processing department's applications maintenance workload has reduced from 70 per cent of their total development effort to about 30 per cent. As a consequence, the data processing department is now able to concentrate its efforts on high pay-back application areas.

Foundation Report No. 11 — Improving Systems Productivity — predicted that, as system productivity aids became available to end users, the data processing department would need to concentrate less on applications development and maintenance than hitherto. Instead, the data processing department's role would evolve into that of the corporate data and communication service. This macro view of the future role of the data processing department is supported by several other researchers (see, for example, reference no. 10). A similar view was presented at the Share 55 conference in 1980 (reference no. 20) by J. A. Zachman, who believes that any major applications development work carried out by the data processing department will concentrate on creating the correct data structure. End users will then define and produce their own input and output programs. Zachman further believes that this change will be accompanied by an increased need for the data processing department to educate and train the end users.

Another consequence of the changing role of the data processing department brought about by the growth of end-user computing will be the need for the department to operate more on an 'arms-length' basis with the end users. End users will be treated more as valued customers, rather than as colleagues, and the data processing department will tend to become more marketing-oriented. Many organisations have already established a structure in which the data processing department actively markets its services to the end-user departments. Some organisations have gone one step further, establishing the data processing department as a separate company with a brief to market its services both to internal departments and to the world at large.

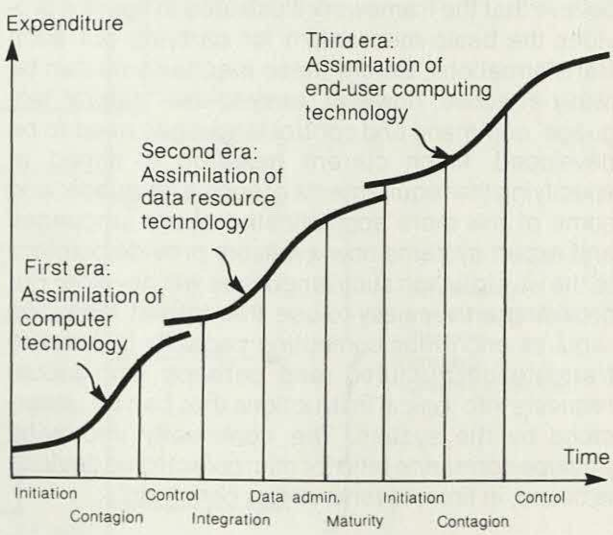
The way in which an organisation chooses to structure its overall information systems function will obviously reflect the corporate structure and management style. There will therefore never be one 'ideal' future role for which the data processing department should strive. We believe that the future role of the data processing department will fall into one of the three possible scenarios outlined by Hamish Donaldson in reference no. 21. In the first scenario the data processing department is responsible for a very large central installation and acts as the information caretaker and provider. The second is a user-driven scenario in which the bulk of the computing workload (including development) is carried out on microcomputers and intelligent terminals. The third scenario is described as one of 'functional modularity', where departmental installations are connected to a small central installation for the purpose of aggregating corporate information.

THE ASSIMILATION OF END-USER COMPUTING TECHNOLOGY

We conclude our discussion of the likely future developments in end-user computing by attempting to place the phenomenon in context with earlier developments in computing and data processing. Richard Nolan has put forward his stages theory to explain the evolution of data processing, and we have discussed the implications of his work in previous Foundation reports (Nos. 11 and 19). The essence of Nolan's theory is embodied in the 'S'-shaped learning curves that organisations inevitably experience as they learn about and adjust to new information systems, and as the systems alter the way an organisation operates.

Nolan believes that the data processing industry has passed through two eras, each of which has three stages. The first era (assimilation of computer technology) consists of an initiation stage followed by contagion and control stages. The second era (assimilation of data resource technology) begins halfway through the control stage, and so overlaps the first era. Thereafter, the second era passes through integration and data administration stages to reach the maturity stage. We believe that the assimilation of end-user computing technology will be the third era in the evolution of data processing, as illustrated in figure 7.

Figure 7 Extension of Nolan's stage theory to include end-user computing



From our research for this report there is evidence to suggest that end-user computing has already passed through the initiation stage in many organisations and is now well into the contagion stage. Assuming that this hypothesis is correct, expenditure on end-user computing will reach a plateau in a very few years' time as organisations attempt to impose a measure of control over its development.

In the second of Nolan's eras, database and transaction processing techniques were used to exploit data and information resources, and these techniques built on the then-traditional discrete application systems developed in the first era. We believe that, in a similar manner, end-user computing will in turn build on and extend the more traditional forms of data processing. Inevitably, computers will be used directly by an ever-widening user population, and more of these users will become what this report has termed 'end users'.

SUMMARY

The range and complexity of end-user applications will continue to increase, particularly in operational areas. End-user hardware and software facilities will become increasingly powerful whilst at the same time becoming more varied and less expensive. Suppliers of end-user computing facilities will increasingly provide families of products that are compatible across the complete range of products. Many of the end-user facilities described in this report will, over a period, converge to form a decision system framework.

The end-user population in most organisations will continue to expand, as the present generation of students, with fewer inhibitions about using computing facilities, work their way through to the first levels of management. As their end-user population expands, many of the larger organisations will establish end-user support services. The brief of the end-user support service, and the success with which it carries out that brief, will have a large impact on the future role of the corporate data processing department. It will, for example, determine whether end users will perceive their computing 'expert' as an end-user intermediary or, alternatively, as a data processing professional allocated permanently to the user department.

The net effect of the future developments in end-user computing will be to increase the organisation's overall level of data processing knowledge and expertise. It is by no means clear whether these developments will cause the data processing department to expand or contract. What is clear is that end-user computing will cause the data processing department to re-think its mission and its methods of working.

CHAPTER 5

END-USER COMPUTING — THE KEY ISSUES

The earlier chapters of this report have shown clearly that end-user computing is already well established in a significant number of large organisations. Our research has confirmed that end-user computing is growing in volume and that end-user applications are becoming increasingly diverse. Significantly, a substantial (and growing) proportion of end-user applications are in operational environments where the success of a part of the business could depend on the success of the applications.

At present the number of end users who develop their own systems form a small proportion of the total number of employees in an organisation. Our research suggests that most of these end users are well aware of the potential impact of their applications on the organisation. In particular, they are aware of the potential pitfalls of their computing activities. In the future the end-user population in an organisation will widen. We believe that, as more and more end users begin to use the new methods and resources, the management services and data processing functions will need to play an active role in the development of end-user computing. If end-user computing is allowed to develop in a laissez-faire manner, some of the potential benefits will not be realised, and many of the potential pitfalls will materialise.

The purpose of this chapter is to set out the key issues that an organisation's management services or data processing department needs to assess as it considers its response to the growing pressure from line departments for their own end-user computing facilities. We firmly believe that an organisation's response to end-user computing can be meaningful only within the framework of an overall information systems strategy. Without such a framework, major policy decisions about end-user computing will fit in awkwardly with existing data processing and communication facilities. If the development of end-user computing is not co-ordinated with other elements of information technology, it could make the subsequent development of an overall information systems strategy extremely difficult, if not impossible. End-user computing should therefore be one element of an overall strategy that also encompasses policies for centralised and distributed processing, communications, applications development and office systems. We now discuss the key issues of the end-user computing element of the strategy under the headings of:

—Attitudes to end-user computing.

—Access to corporate data.

—Evaluation and selection of end-user facilities.

—Evaluation and selection of end-user applications.

—Security issues.

—Charging policy.

—Organisational issues.

ATTITUDES TO END-USER COMPUTING

The management services and data processing functions must formulate their attitudes to end-user computing. There are only three options — to encourage end-user computing; to discourage end-user computing; or to adopt a neutral attitude that allows end-user computing to develop with neither encouragement nor discouragement. Different organisations will have valid reasons for adopting one or other of these three attitudes. Their choice will depend on several factors, including their past history of using data processing facilities, management style, corporate culture, and whether the organisation is basically centralised or decentralised. Nevertheless, the organisation's attitude to end-user computing needs to be explicitly adopted after due consideration, and should be reviewed at regular intervals.

Encourage end-user computing

The most likely consequence of actively encouraging end-user computing is that it will develop at a faster rate than might otherwise have occurred. A rapid growth in the use of end-user computing facilities will have an impact on hardware and software requirements and on the level of end-user support that the organisation needs to provide. For example, if the end-user computing facilities are provided by linking terminals or microprocessors to a central installation, then a rapid growth in the number of terminals will have significant implications, particularly for the amount of main storage and backing storage required at the central site. A rapid growth in the number of terminals may also require the processing power of the central installation to be enhanced, although this will depend to some extent on the software being used.

Encouraging end-user computing will also mean that the number of end users will grow rapidly, and the newcomers will need substantial support. Such an attitude therefore has significant implications for the amount of end-user support that is required, regardless of whether an end-user support service is established.

Discourage end-user computing

Active attempts to discourage end-user computing can probably succeed only in the most autocratic or highly centralised organisations. In other types of organisation there is always the danger that attempts to discourage end-user computing will make some end users even more determined to proceed with their own projects. If such clandestine activities are restricted to a few isolated applications there is probably no reason for enforcing a 'no end-user computing' policy. But if some of them turn out to be extremely successful and gain the support of the user's own senior management, the credibility of the management services or data processing department could then be questioned.

One possible compromise is for the management services or data processing department to adopt a helpful attitude whilst still discouraging end users from developing their own applications. The experience of one of the organisations we interviewed provides a model for this approach. This organisation encourages users to acquire their own microcomputers, but discourages them from developing their own applications. The microcomputer systems manager (who works for the data processing department) helps the end user to identify and evaluate proprietary application packages that might meet his or her requirements. If a suitable package cannot be found, the microcomputer systems manager then determines whether an existing in-house application from another department meets the requirements, or could be modified to meet the requirements. If no such application is available, the data processing department will then try to identify a need for a similar application in other parts of the organisation. If such a need is identified the data processing department then develops the application on behalf of the users. Only if all these steps fail is the end user allowed to develop the application himself. Even then, the data processing department advises the end user on the best software development approach to adopt.

Adopt a neutral attitude to end-user computing

The main consequence of adopting a neutral attitude to end-user computing is that there is then little opportunity to influence its direction or rate of growth. If end-user computing develops in an uncontrolled and unco-ordinated way it could lead to unforeseen requirements for hardware and software, and for demands for end-user support that cannot be met from existing staff resources. It would also certainly have an impact (probably an adverse one) on any information systems strategy.

ACCESS TO CORPORATE DATA

The criteria for deciding who shall have access to corporate data should be part of the data management policy, which itself is an element of the information systems strategy. The basic issue for end-user computing is whether users should have direct access to corporate files, or whether their access should be through an extracted file, which is typically a small subset of the corporate data.

Direct access

Organisations tend to be wary of allowing end users to access corporate files directly because of fears about security and efficiency. Mainframe computer suppliers are continually improving the security aspects of their file handling subsystems, however, and software suppliers are now offering enquiry and report packages that allow corporate data to be accessed directly with reasonable efficiency and security. We believe that organisations should not as a matter of course preclude end users from having direct access to corporate files, particularly for major operational applications.

Nevertheless, permitting end users to have direct access to corporate data does have several disadvantages. It may be necessary to have larger subsets of the corporate files on-line at any one time than would otherwise be necessary, and there will be a cost associated with the required on-line storage devices. Also, end users may assume that, because their programs have on-line access to the corporate data, all the data they retrieve is consistent and up to date. For example, an end user may retrieve information from one part of the corporate database and carry out some local manipulation on the data. He or she may then retrieve data from another part of the database in order to continue with the manipulation. The end user may be completely unaware that since the first access to the database the original information has been updated, and the data retrieved during the second access corresponds to the updated information. Thus, not only may the final results of the calculation be wrong, but the user may be completely unaware that they are wrong. Very sophisticated and complex database management software and operating procedures are required to prevent this type of situation arising.

Extracted data

The main advantage of allowing end users to access corporate data via an extracted subset of the data is that it provides the users with a consistent 'snapshot' of the relevant parts of the database. Many data processing departments (and software suppliers) argue that a static snapshot is of more use to end users than a constantly changing 'live' database. They argue that end users typically manipulate the data in an iterative manner to identify a particular trend or to arrive at a conclusion about some particular aspect of the company's performance. Thus, end users typically carry out an iterative series of calculations during a working day, or even over a longer period that may vary between a week and a month or two. Furthermore, during each iteration they perform the calculation on a different set of data items. A static snapshot of the database is obviously more suitable than a live database for this type of computing.

In the organisations that we surveyed, the programs to create the extracted database were invariably written by the data processing department rather than by the end user or end-user intermediary. In the few organisations that had allowed the end user to write the extraction program, the data management facility provided various privacy and authorisation mechanisms that ensured that only the authorised subset of the database was extracted. Such mechanisms also ensure that the corporate data resource is used only by authorised end users.

Extracting data for use by end users does have disadvantages in terms of cost, effort and the time required to carry out the extraction on a regular basis. If large volumes of data are extracted, this data will need additional on-line storage. Also, end users have a tendency to retain previous versions of the extracted data, and it is all too easy to consume an ever growing amount of backing storage which contains out of date information that is probably no longer required.

EVALUATION AND SELECTION OF END-USER FACILITIES

Our research showed that the data processing department of an organisation usually evaluates the end-user computing facilities that are subsequently placed on approved lists of available products and suppliers. But we found little evidence that the requirements of individual end users or applications were being matched against the available facilities. Some organisations argued that it was not necessary to carry out a detailed evaluation at the individual end-user or application level, because this could lead to end users having to come to terms with a plethora of products. They believed that most end users would rather learn how to use one type of facility that could provide a satisfactory (if not ideal) solution to most of their requirements.

Although this is a powerful argument, we believe that organisations should carry out some form of evaluation of the end-user computing facilities to be installed in a particular department or office or site. At the very least, the evaluation can take the form of a checklist of the relative strengths and weaknesses of the available facilities. Such an evaluation is particularly important before software facilities are selected. We found that, because software is less visible to potential purchasers, more attention was often given to evaluating the hardware. Yet, for end users, software is by far the most important element of their total computing facility.

EVALUATION AND SELECTION OF END-USER APPLICATIONS

Once an organisation has decided on its overall attitude to end-user computing and has laid down the framework within which end users can select facilities and access corporate data, the next key issue is to determine whether an individual application should be implemented as a data processing application or as an end-user application. For distinctly once-off applications the choice may be obvious: these are clearly better developed as end-user applications. But the answer may not always be clear-cut, and there are a number of factors that an organisation should take into account in making the choice. Among these factors are several general criteria, such as:

- The end user's ability to use the facilities that would be required to support the application.
- The nature and amount of end-user training that would be required.
- The total costs of implementing a data processing or end-user solution to meet the particular requirement (including equipment costs, software and training costs, the costs of implementing new or modified procedures, development costs and maintenance costs).
- The relative merits of the two approaches from security, privacy and auditing points of view.

We now provide guidelines for organisations to use in evaluating and selecting end-user applications. The guidelines are discussed under the headings of approval criteria, equipment requirements and life-cycle costs.

Approval criteria

Some organisations may decide that once a user has access to end-user computing facilities there is no need to approve the development of individual applications. Others may decide to set a threshold below which no approval is required. Such a threshold might be specified in terms of the size of the application, its type, its likely impact on the business, the cost of developing it, etc. Criteria for approving end-user applications must then be established, using a procedure that is helpful rather than discouraging. The procedure must therefore be simple to follow, clear and concise.

For end-user applications of any reasonable size or complexity, we recommend that the user's own manager, together with the data processing, internal auditing, and organisation and methods departments should be involved in the approval process. The process begins with the end user preparing a short requirements document (perhaps as short as one page). The data processing department will then estimate the effort and cost required to develop and run the application, and will advise the end user on the feasibility of implementing it. In addition, the data processing department will take account of any implications that the application may have for the data management and communication policies. It will also advise the end user about facilities that might be suitable for the application, and about the amount and level of technical support that would be required. In particular, the data processing department will ensure that the end user is aware of any similar requirements or applications elsewhere in the organisation.

The internal auditing department will review the potential application from the viewpoints of possible fraud and of value for money. The organisation and methods department will advise the end user of any mechanical or manual methods that could solve the problem in a faster or less expensive way. In addition, the organisation and methods department will review the human procedures associated with the proposed applications. The user's own manager will review the proposed application in relation to the need it meets and the likely benefits it provides.

In the event of a conflict of opinion between the data processing department and the user's manager, an end-user steering group (if such a group exists) could be asked to arbitrate. (The role of an end-user steering group is discussed on page 31.) Alternatively, if no easy compromise can be reached, and if the potential impact of the application warrants it, a joint review by the management services executive and user department manager (or director) may be necessary.

Equipment requirements

The data processing department needs to evaluate the impact that proposed end-user applications would have on centralised computer installations. Adding terminals to a mainframe will not be too expensive if there is spare processor and memory capacity. But if the processor needs to be upgraded to accommodate additional end-user terminals, the organisation could be faced with a substantial increase in its central hardware costs. The impact of end-user oriented software must also be considered. For example, an APL facility can generate huge demands for processor time, and most end-user facilities tend to generate a substantial amount of input and output. Also they can be particularly demanding in terms of the amount of on-line storage they require, especially if they are used to access corporate data files. If end-user applications are to be implemented on distributed hardware, the data processing department needs to consider also the additional communications load that will be generated by requests to access the central corporate data files.

In many respects it is easier to implement end-user applications on dispersed hardware installations that are not interlinked to each other or to a central installation. The obvious proviso is that the installations must have spare capacity to accommodate end-user applications. Many dispersed installations are departmental minicomputers that are, in effect, pre-packaged machines configured for a specific application. Consequently, they have very little spare capacity for running extra applications. In addition, many such installations were selected on the basis of the characteristics of the application rather than for their hardware characteristics. Often, they are either unique pieces of hardware that cannot be upgraded, or they are at the top end of a hardware range, which also makes upgrading difficult.

A potential end-user application often requires the user department to acquire its own microcomputer. Our commentary in chapter 3 on users' experiences disclosed that many organisations do not yet have a clear policy concerning the evaluation and selection of microcomputers. In that chapter (on page 15) we listed the elements of one organisation's policy, which we recommend as a good basis. The need for a clear microcomputer policy becomes ever more necessary as both the variety and capability of the different products increase. End users are increasingly vulnerable to extravagant claims made for various microcomputers. In addition, the long-term viability of some of the vendors currently in the marketplace must be in doubt. An organisation needs to ensure that it takes account of all relevant factors when it purchases microcomputer products.

Life-cycle costs

When an organisation decides whether an application should be developed as a data processing or an end-user application, it needs to take account of the relative costs associated with the two approaches for developing, running and maintaining applications software. In general, end-user applications cost less to develop and maintain than an equivalent data processing application, but they cost more to run. Thus, the relative life-cycle costs of the two approaches depend on the frequency with which the application will be used and the anticipated rate of change. For an application that will be used only a few times and is then discarded or changed substantially, it will be more cost-effective to develop it as an end-user application.

A further advantage of end-user applications is that, because they take less time to develop than the equivalent data processing application, the organisation receives the benefits at an earlier date. The costs associated with delaying the benefits should therefore be taken into account when the total costs of the two approaches are compared. We found that only a small number of organisations (and even fewer end users) had compared the total life-cycle costs of the two approaches in the way we have just outlined. But our conversations with end users convinced us that, intuitively, they were using computers in a direct, active and creative manner so that they could gain the benefits from the applications earlier than they could by waiting for the equivalent data processing applications.

SECURITY ISSUES

If the organisation's end-user computing policy permits end users to develop operational applications, then procedures must be laid down to ensure that those applications are secure. The procedures should ensure that the applications cannot be used by unauthorised users and that they cannot be used for unauthorised access to private or sensitive information. Also, if the applications are to be used to handle financial transactions, the internal auditing department must be involved as the application is developed and also when it has been implemented as an operational system.

Organisations need to ensure that operational applications developed by end users are reliable and can be changed easily should the requirements change. We believe that end-user applications are particularly vulnerable in these respects if end users are allowed to make significant modifications to a standard applications package. There are three main dangers:

— The package supplier is absolved from his responsibilities.

— Our research showed that it is easy for inexperienced end users to make changes that appeared to work satisfactorily even though the results may not be correct.

— Future maintenance of the package becomes an increasing burden.

Because of these dangers we advise organisations to establish procedures that will discourage end users from tampering with applications packages.

Another aspect of security is the level and standard of documentation for end-user applications. Most end users produced useful user guides, but none of the end users we spoke to produced documentation that was specifically designed as an aid to future maintenance of the application. It is difficult, if not impossible, for the data processing department to ensure that such documentation is produced by the end users. The most likely method of enforcement is through an end-user steering group or through the user's own manager. User departments need to be made well aware that as their operations become more reliant on end-user computing applications, the need for adequate maintenance-oriented documentation becomes even more important.

CHARGING POLICY

The end-user computing charging policy needs to be carefully defined, because it can have a significant impact on the activity. If end users are not charged for the facilities they use, the cost of running the resulting service could be high and end-user computing as a whole could be less than cost-effective. On the other hand, if the charges are too high, end users may be deterred from using the service and, as a result, may continue to use external computer bureaux for their computing activities. The charging policy adopted should of course be consistent with the organisation's practices for charging out other central services. A significant proportion of the organisations we surveyed did not, in fact, charge back the full costs of providing end-user computing services. Instead, they charged only for explicit costs incurred by end users, such as hardware and the purchase of software packages. Running costs and costs associated with an end-user support service were not charged back directly to end users, but were regarded as part of the central overheads budget.

Whatever type of charging policy is adopted, we believe that end users should receive a regular statement showing the total costs of their end-user computing. In this way the user department will be aware of its total end-user computing costs, and the organisation as a whole will be aware of the total costs associated with the activity.

ORGANISATIONAL ISSUES

There are three key organisational issues in relation to end-user computing. The first issue is whether the computing expertise should be encouraged to reside with what we have termed end-user intermediaries or, alternatively, with data processing staff who are allocated permanently to user departments. The second concerns the establishment of an end-user steering group, and the third concerns the establishment of an end-user support service.

Location of end-user computing expertise

End users need ready access to a local computing 'expert', and there are two alternative ways of meeting this need. User departments can be encouraged to develop their own expertise (that of end-user intermediaries), or a data processing expert can be assigned permanently to the user department. (We described the somewhat subtle but nevertheless significant differences between the two approaches in chapter 1.) Established corporate practices may provide a pointer as to which approach should be adopted. Some organisations centralise all staff functions, whilst others distribute the functions so that individual divisions and departments have (for example) accountants and personnel officers assigned to them.

Both approaches have their drawbacks. Data processing staff assigned to user departments may face potential problems in pursuing their long-term career aims in the data processing industry. They may also be paid significantly more than the end users they work with. Similarly, an end-user intermediary may know as much about a particular branch of computing as does a data processing colleague, but may be paid significantly less. The intermediaries may also feel increasingly out of touch with their own profession and, as a result, become concerned about their long-term career prospects.

End-user steering group

Organisations that decide to encourage the development of end-user computing should consider establishing an end-user steering group. But such a group can be viable only if there is a wide spread of end users in many different user departments, and if an information systems (or data processing) steering group is functioning effectively. The purpose of an end-user steering group is to provide guidance for the overall direction of end-user computing throughout the organisation and, in particular, to guide the data processing function in servicing the activity. The group will assist the data processing department to enforce the guidelines that have been laid down for documentation standards, for systems security, and so forth. It will also provide a means for ensuring that end users receive a fair share of the corporate information systems budget. The chairman of the group will ideally be an end user or the manager of an end-user department, and he or she will also sit on the information systems (or data processing) steering group. The secretary of the group will be the end-user support service manager.

End-user support service

We believe that an end-user support service is a prerequisite for those organisations that wish to encourage the development of end-user computing. But even if the organisation has decided to discourage the activity, it may still find it worthwhile to establish some form of end-user support service. In this latter case the support service would be much smaller and its main objectives would be to manage and control the end-user computing activities — more of a policing role than a developing and assisting role. For those organisations who wish to encourage end-user computing, the purpose of the end-user support service can be likened to the role of the customer support department in an external profit-oriented and market-oriented computer bureau.

From our research it is clear that the current stage of development of end-user computing demands that organisations take heed of the key issues identified in this chapter. Organisations need to formulate policies and plans to guide (and perhaps control) the development of end-user computing. One of the key elements of these plans is the formation of an end-user support service. Such a service can be oriented either to control and restrict the activities of end users, or to assist end users in enhancing their computing. The next chapter provides detailed guidelines for establishing and running an end-user support service.

CHAPTER 6

GUIDELINES FOR AN END-USER COMPUTING SUPPORT SERVICE

One of the principal recommendations of this report is that those organisations who decide to encourage the development of end-user computing should establish an end-user computing support service. We have already suggested that the role of the end-user support service resembles that of the customer support department in a computer bureau. Thus, its primary roles are to encourage the use of the available end-user computing facilities, and to provide advice and guidance to the end users. Its activities will include education and training, advice about the use of development aids, assistance with accessing corporate data, provision of technical support and overall administration of end-user computing throughout the organisation. The manager of the support service may also have a role to play in advising about the recruitment and career progression both of staff employed as end-user intermediaries and of data processing staff who are allocated permanently to end-user departments.

The aim of the end-user support service is to assist end users to employ their computing facilities in the most effective way for the benefit of the organisation as a whole. The terms of reference for the end-user support service should therefore be defined clearly by the corporate information systems strategy. The terms of reference should also specify the responsibilities of end users in terms of applications knowledge, cost justification of applications and supplying (and managing) the resources required for developing and maintaining applications.

The end-user support service needs to be staffed by personnel who have a sound understanding of computing techniques but who are more interested in the application of computing to solve business problems. The manager of the end-user support service will probably report to the management services or data processing manager, but he should be viewed by the end users as their representative or advocate in the data processing department. Those organisations who have structured their information systems department as a separate profit-oriented subsidiary will find that an end-user support service is a natural component of their business.

We now set out the guidelines that an organisation can follow, first as it establishes its end-user support service, and then as it markets the services of the end-user support function to the rest of the organisation.

ESTABLISHING THE END-USER SUPPORT SERVICE

Once the need for an end-user support service has been identified and its terms of reference have been specified, the first action to be taken is to appoint the manager of the service. The person appointed must be technically competent, but it is even more important that he or she is aware of the business opportunities presented by end-user computing. The manager must therefore be more interested in what computers can do for users than in the technical excellence of any particular solution. The person appointed must, above all, be acceptable to the senior management of the end-user departments because, in many respects, he or she will be their representative in the management services or data processing department.

The major tasks involved in establishing the end-user support service can be classified as defining the action plan, recruiting staff and initiating the service. In general terms, those tasks will be performed in the chronological sequence in which we discuss them although, in practice, some of them may proceed in parallel.

Defining the action plan

In defining the action plan for establishing the end-user support service, the manager of that service must first establish the organisation's present level of knowledge and use of end-user computing facilities. The manager then needs to determine the level and type of end-user support service that is required to meet the future needs of end users and, finally, he or she must decide how the organisation will be transformed from its present position to the required support position. Several distinct activities need to be performed in order to make this transformation, as we now discuss.

Establish the present position

It will be much easier to establish the present position of end-user computing in the organisation if an end-user steering group has been formed (see page 31). If such a group has not been formed, then the end users should be made well aware of the terms of reference of the end-user support service before any fact finding is begun. If end users do not understand the purpose of the proposed support service, they are likely to regard any fact-finding exercise with suspicion. Many of them may suspect that the data processing department is gathering ammunition that will be used to obstruct their 'do-it-yourself' computing plans.

The aim of this activity is to gather comprehensive information about existing end users, their applications, the hardware and software they are using, the level of documentation they have produced, the problems they have encountered, the benefits they have realised from their applications, and so forth.

Assess the potential demand
It will not be easy to assess the potential demand for end-user computing facilities because existing end users may not know what facilities they will require in a few years' time. In addition, the vast majority of an organisation's employees cannot at present be classified as end users. Many of these could become end users in the future if the 'right' facilities were available at the 'right' price. (In many respects, the future demand for end-user computing is subject to the 'motorway' effect we described for data communications in Report No. 28.) Thus, the installation of end-user computing facilities could unleash a huge latent demand.

Despite the difficulty of estimating the potential demand, some attempt to do so should be made. At the very least, the estimate can be compared with the actual subsequent growth in end-user computing, so that any major variations can be highlighted at the earliest opportunity. A good starting point is to assess the demand for end-user computing facilities among staff functions and headquarters departments.

Evaluate the options
The next task for the end-user support manager is to evaluate the various hardware and software options that are available for implementing an end-user computing service. Because of the diversity of available products, this will not be an easy task, and the range of options is widening all the time as new and more powerful products are brought to the market. In practice, it will not be possible to evaluate all of the options, and it is almost inevitable that the chosen solution will be superseded by a new product release soon after the decision is made.

Nevertheless, we recommend that an attempt be made to evaluate the options available for the more basic facilities, and to produce a checklist of the suitability of the potential products. For example, if most of the potential demand is for accessing and then manipulating aggregations of corporate data, then APL or stand-alone microcomputers are not the right tools. In chapter 2 we classified end-user computing facilities under five broad headings. We believe that this broad classification will be of value as organisations evaluate the options. In addition, there is a growing body of practical experience from those organisations which have already appointed end-user support managers. A representative sample of that experience was related in chapter 3.

Define the implementation phases
For many organisations, end-user computing and the establishment of an end-user support service is a radical departure from their traditional approach to data processing. Because of the fundamental changes that end-user computing represents, many organisations will therefore wish to establish the end-user support service in a phased manner. When defining the action plan, the end-user support manager must therefore consider the way in which the introduction of his or her staff will be phased, and the way in which the support they provide will be phased. For example, the manager may decide that, initially, only support for a particular type of microprocessor will be provided, or that support will be provided only for departments located in a particular building. Nevertheless, the action plan should also contain detailed plans for the second phase of support, and these plans should be agreed from the outset. The action plan should also contain outline plans for subsequent phases together with the criteria for deciding if and when they should go ahead. In this way, the action plan should be formulated so that (for example) a three year phased programme for establishing the end-user support service can be agreed in principle.

Determine team size and skills required
In determining the team size, the end-user support manager will need to take account of the existing level of end-user computing expertise in the organisation and the potential demand for end-user computing facilities. The level of service provided should be defined in terms of the ratio of support staff to end users. In chapter 3, we reported that this ratio varied from 1:150 to 1:5. The average was about one support staff for every 20 to 30 end users, and we believe that this average is a good starting point for a new end-user support service. Care is needed when deciding whether certain casual users should be included in the total count and whether the existence of end-user intermediaries has an effect on the required ratio.

The skills required by members of the end-user support team will depend on the facilities that are to be supported. If a wide range of facilities is to be supported, it is unlikely that any one person will have all of the required skills. For example, the skills required to support end users in the use of the VisiCalc or Micro-Modeller products on a stand-alone microcomputer are very different from those required to support the use of APL or the use of a proprietary database package to access corporate files. The team members must therefore provide the appropriate mix of technical skills. They must also provide a mix of application-oriented and user-oriented skills.

Recruiting staff

Once the action plan has defined the size of the end-user support team and the skills required, recruitment of the team members can begin.

Potential candidates for positions in the end-user support team may come from any of the following internal sources:

—The data processing department.

—Other parts of the management services department.

—Staff currently performing an end-user intermediary role.

—Staff currently acting as user-liaison officers.

The data processing department is an obvious source of potential candidates, but care should be taken to assess how any applicant from this department will react to an environment involving a large amount of regular interaction with the users. It is also important to assess the likely performance of data processing staff in an environment containing a large number of simultaneous but relatively small projects, nearly all of which are outside their direct control.

Members of the end-user support team may also be drawn from other parts of the management services department, including operations research and organisations and methods. Such applicants should be assessed for their potential technical ability.

Staff currently acting as end-user intermediaries are also potential candidates for the end-user support team, but our research indicated that such staff rarely considered furthering their career within the data processing department. Because of strong loyalties to their existing profession, function or department they are unlikely to be attracted by a position in the end-user support team.

Finally, some organisations have appointed a liaison officer who is the user department's nominated primary link with the data processing departments. Some liaison officers may be suitable candidates for a position in the end-user support team.

Initiating the service

Most of the activities that are required to initiate the end-user support service have already been described as part of the key issues in chapter 5. To initiate the service, the end-user support manager needs to define procedures for ensuring that the appropriate actions are taken on a continual basis. We recommend that simple procedures for use by end users should be established under the following headings.

Guidelines and standards

End users should be provided with a document that contains a condensed and simplified version of the relevant parts of the organisation's end-user computing guidelines and standards. It should contain sections on:

—Requirements specification.

—Systems and data analysis.

—Design principles and specification.

—Development and testing.

—Documentation.

—Maintenance.

—Security and auditing of systems.

The written material should be supplemented by meetings and teach-ins for those end users who desire more detailed information.

Applications criteria

An agreed list of criteria for testing the suitability of prospective end-user applications should be drawn up. The criteria should be designed to determine whether the requirements of a particular application can best be met by using a proprietary package, an existing in-house system or a system developed by the data processing department.

One approach to assessing the suitability of prospective applications was given by Peter Entwistle of Lloyds Bank at the Seventh Foundation Management Conference held in Venice in May 1980. Full details are contained in the conference transcript but, in outline, each application is tested against plus criteria and minus criteria. The plus criteria include such items as:

—The application generates its own data.

—The application needs to use only extracted corporate data.

—The application presents no privacy or security risk.

—The application needs to be developed quickly.

—A very high-level language can be used to develop the application.

The minus criteria include such items as:

—The application requires rapid on-line response times.

—The application depends on a large network of terminals.

—The application needs to be used outside normal hours.

—The end users are unwilling to provide resources or to accept responsibility for the application.

Evaluation and selection of facilities
Procedures for evaluating and selecting the basic facilities that are to be made available to end users must be established, together with procedures for matching individual end users' requirements against the available facilities. Care must be taken to ensure that the procedures prevent lengthy or costly evaluations for applications that will only be used a few times.

Cost-benefit criteria
The end-user support manager should ensure that procedures are established for estimating the overall costs and benefits of all end-user applications. We recommend that the end users should be responsible for estimating the benefits, and the support service should be responsible for estimating the costs. All costs, including development costs, maintenance, hardware, software, capital and running costs, should be included in the estimates.

Development and teaching aids
The end-user support department should establish procedures to ensure that relevant end-user development and teaching aids are acquired from suppliers and from other organisations. In addition, the department should plan to develop specific end-user aids as necessary. Procedures for disseminating information about the available aids should also be established.

MARKETING THE END-USER SUPPORT SERVICE

A newly formed end-user support service is likely to find that end users (and prospective end users) are initially suspicious of the services offered. Existing end users will see the end-user service as a threat to their independence, while prospective end users may not take kindly to the idea of developing and running their own systems. The end-user support service will therefore need to market itself and the concept of end-user computing to the organisation as a whole.

A good starting point for making the organisation aware of the end-user support activities is for the service to publish a regular bulletin or newsletter. The aim of the newsletter is to publish information that will enable end users to reduce the effort required to develop and run their own systems. It will therefore contain information that will enable end users to assist each other, so minimising the unnecessary duplication of effort. The newsletter will also provide a channel for the end-user support service to disseminate information of general interest, such as the availability of a new product or the programme of a training course. As part of its overall 'marketing', the end-user support service should initiate a pre-planned and regular programme of general systems training for end users, and in particular for those who will act as end-user intermediaries.

One particular area of difficulty for a newly formed end-user support service will be its relationship with those end users who had already established their computing practices before the new service was formed. For end-user computing to be really effective for the organisation as a whole, it is inevitable that the end-user support service will need to change the procedures and practices of some of the early end users.

The procedures and practices introduced by the support service must have the backing of the end-user steering group or the information systems steering group. In the absence of such a group, the backing of top management in the end-user departments is required. But, to be really effective, the procedures and practices have to be enthusiastically endorsed by the middle and junior managers who actually have to make them work in the user departments. Without their active support, the required documentation will not be produced, adequate cost-justification will not be performed, and other necessary controls will not be implemented.

The support service should strive to build a relationship of trust with the end users so that, when they use a new facility for the first time, they welcome the direct and active assistance of a member of the support team. In this way, the support service benefits by experiencing for itself the capabilities and limitations of the particular end-user facility, and also by obtaining a first-hand assessment of the data processing expertise of the end user. The end user also benefits because, in addition to the normal general help and guidance provided by the service, he or she is able to learn by working with an experienced computing professional.

From the discussion in this chapter on the guidelines for establishing and running an end-user support service, it is clear that the service needs to be staffed by people who have a good all-round knowledge of all aspects of data processing and its application. We believe that the end-user support staff have a vital role to play in ensuring that an organisation makes the most effective use of information technology. End-user support staff should certainly be more than just very good technicians. For an end-user support service to be really effective it needs to be staffed by high-calibre people. In data processing terms, this means those staff who have the potential to become data processing managers.

CONCLUSION

The purpose of this report has been to clarify the nature and scope of end-user computing and to outline its role in relation to corporate data processing. The report has shown that end-user computing constitutes as much as ten per cent of the computing workload in some organisations, and that it is growing rapidly. The development of end-user computing cannot be ignored by an organisation's management services or data processing department.

Our research has identified the present majority of end users as professionals employed at head office in middle management or staff functions. Most of their applications are used a few times and are then discarded, and most end-user products are designed to be used as self-contained stand-alone facilities. But our research has also indicated that the present nature of end-user computing is changing rapidly, in terms of both end users and applications. More and more employees of various types will be introduced to end-user computing, and more of their applications will be used to control a part of the business in a day-to-day operating environment.

Our research has shown that, to date, the majority of end users are satisfied with their computing experiences. In general, their applications have been successful and are making a worthwhile contribution to the user departments. However, our findings about the way in which end-user computing facilities are evaluated and selected, about the design and documentation of applications and, to a lesser extent, about end-user education and training lead us to recommend strongly that Foundation members should pay much closer attention to end-user computing. In particular, those organisations that already have a substantial number of end users but have no end-user support service should consider establishing one.

We believe that end-user computing will continue to grow rapidly and we predict that it will represent the third major era of computing. (The first two eras were the assimilation of computer technology and the assimilation of data resource technology.) At present, end-user computing represents a relatively small proportion of most organisations' expenditure on data processing. If organisations wish to direct and control the future growth of end-user computing they need to act now and address the key issues identified in chapter 5. We believe that the experience we have related in this report and our analysis of the nature and future development of end-user computing will assist Foundation members both in exploiting the opportunities that it offers and in minimising the risks that it presents.

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