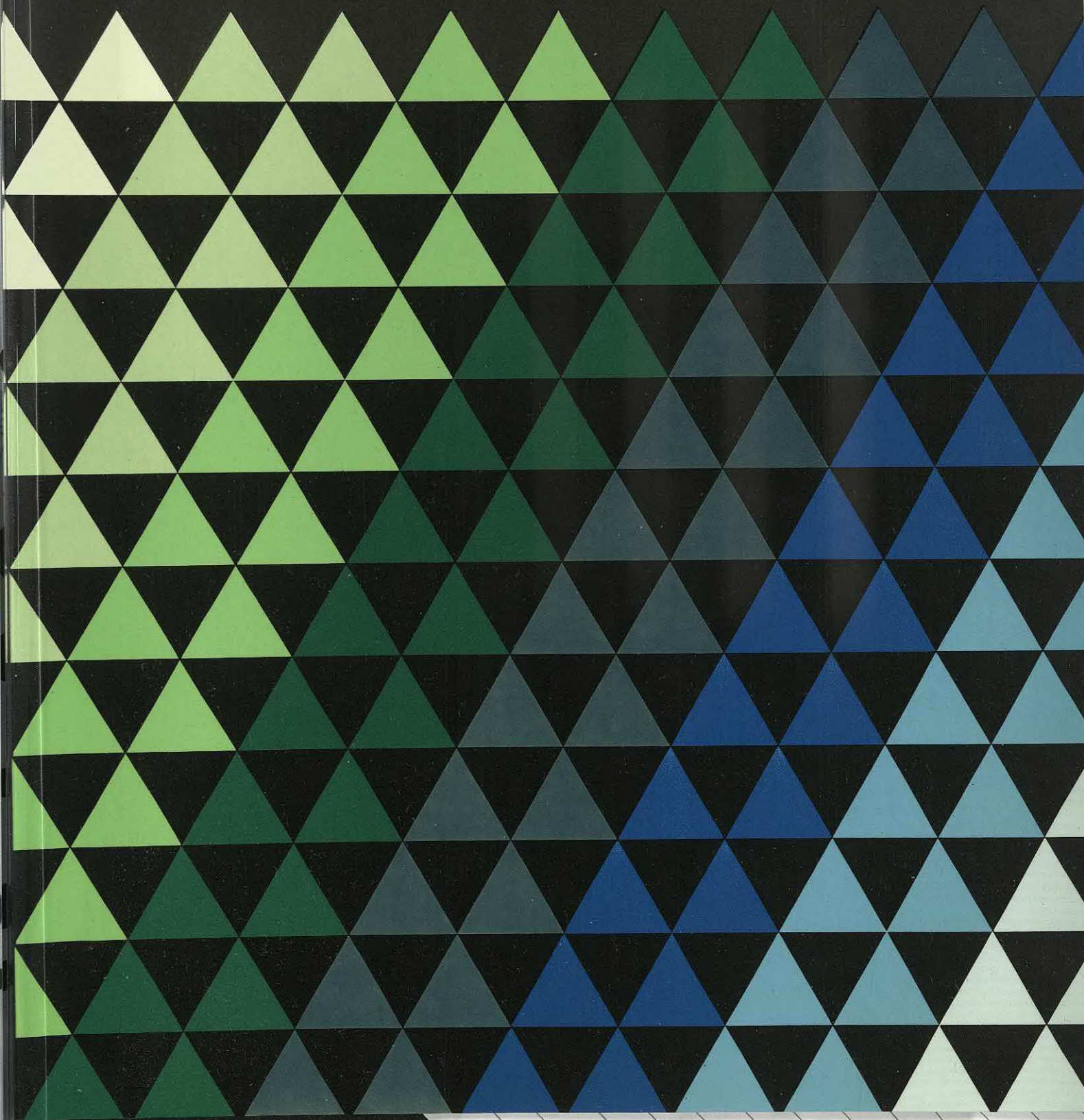
# The Future of the Personal Workstation

BUTLER COX FOUNDATION

Research Report 63, April 1988



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Research Report 63, April 1988

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# The Future of the Personal Workstation

## Research Report 63, April 1988

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## Management Summary

A Management Summary of this report has been published separately and distributed to all Foundation members. Additional copies of the Management Summary are available from Butler Cox

# Chapter 1

# Changing importance of the workstation

The word *station* has been used in the context of *work* for many centuries. Perhaps the most dramatic use has been in the naval expression 'man the battle stations' where *station* is used to define the individual sailor's work area and, most importantly, where he will find the tools to perform his duties.

The information systems profession, however, has tended to use a less romantic and more restrictive definition of the expression *workstation* — generally employing it to denote a rather specialised technical device used to assist engineers in their complex design and drawing tasks. For the purposes of this report, we will return to a broader, more-traditional definition — thus, we include dumb terminals, standalone personal computers, and linked personal computers that are connected either to each other or to an organisation's mainstream computer, or a mixture of both. Our definition does, of course, embrace the engineer's technical workstation, which now provides many other functions in addition to design and drafting.

The word *personal* is also important, denoting both a sense of personal productivity from the tool and a sense of personal responsibility for looking after it in some way. Sailors have always been responsible for cleaning and storing their weapons, and for ensuring they do not cause any accidental damage with them.

In the pioneering days of personal computing, personal workstations were just that — a *personal* productivity tool, and their use was limited to a few specialists in the organisation. The fact that the specialists had difficulty in using the tool and frequently corrupted their programs and data and had to start again was sad, and the more enlightened systems departments tried to help by providing training and some assistance. However, the cold reality of this situation was that the problems (like the workstation) were *personal* and did not impact on the rest of the organisation or its other computing interests. Today, though, the use of workstations is widespread, and the problems of using the tool are no longer localised — they now extend to the *departmental* and *corporate* levels. Users who had difficulty in manipulating their own local data now have to grapple with the problem of accessing remote data through a maze of emulators, code convertors, communication layers, host operating systems, and so on. Furthermore, the potential impact of a user-initiated corruption is much more severe than when workstations were used just as a personal tool.

Our research has shown that users no longer perceive workstations as just a standalone, personal tool. They want to use their workstations to interact with information held on any of the organisation's processors in as simple and inexpensive manner as possible. In particular, they want the interaction to be the *same* irrespective of the types and makes of the processors or the software they run. In striving to meet this very reasonable objective, organisations are confronted with a confusion of products and suppliers, with a lack of standards for software, interfaces, and communications, with changes to the ground rules (the operating system, for example), and with a lack of enthusiasm and support from their own systems department.

We believe that the suppliers will address many of the problems facing workstation users over the next five years. Unfortunately, the same cannot be said of systems departments, many of which have distanced themselves from their workstation users and are ill-equipped to service the emerging multifunction, interworking requirements. This report highlights these requirements and what Foundation members must do to satisfy them.

## SCOPE OF THE RESEARCH

Our research concentrated on multifunction workstations used by managerial, office, and professional staff, rather than on industry-specific workstations such as cash-dispensing (banking) terminals or supermarket checkout terminals. Our analyses, however, distinguish three types of workstation: dumb terminals, standalone intelligent workstations (which, hitherto, have been known as personal computers), and linked intelligent workstations. Dumb terminals have no applications logic residing in them; the applications software resides on a host processor to which the dumb

terminal is connected. Intelligent workstations equate to today's PCs, which may either be used as standalone devices or linked to each other and/or to mainframe processors.

The research carried out for this report consisted of:

- Analysis of 134 replies from Foundation members received in response to the original document describing the proposed scope of the research.
- In-depth interviews and discussions with 44 organisations (from nine countries) that, between them, were using 145,000 personal workstations (as at October 1987). These organisations were selected to provide a representative cross-section of industries, size, and maturity in terms of using workstations.
- Interviews with the suppliers and research organisations that will shape the future of the personal workstation. In all, we met with 29 organisations and individuals.
- An extensive literature search.

We have also made use of the experience and ideas that have arisen from Butler Cox consultancy assignments and from the personal knowledge and practice of the members of the research team. The research was international, covering suppliers and users in Europe, users in the Far East, and suppliers in the United States.

The research was led by Lilian Lodge, Butler Cox's manager of business systems consultancy. She was assisted by David Flint, a principal consultant with Butler Cox in London, by Simon Forge, a senior consultant with Butler Cox in Paris, and by Neil Hallett-Carpenter, a consultant with Butler Cox in London.

## PURPOSE AND INTENDED READERSHIP

This report alerts Foundation members to the heightened importance of personal workstations within an organisation's overall information systems architecture and highlights the resulting actions that Foundation members may need to take sooner rather than later. In so doing, the report positions the personal workstation within the overall systems architecture, suggesting that, for many organisations, a two-level architecture based on mainstream systems and linked workstations will be sufficient. The position results from many factors including: natural evolution as workstation users become more experienced and have increasing aspirations; new opportunities presented by equipment and software innovation; and new opportunities as prices continue to be reduced.

The report also highlights the shortcomings in products and in systems departments' policies that will hinder the exploitation of the personal workstation, and discusses the extent to which the shortcomings are likely to be overcome in the next five years. In particular, it discusses standards for workstations and for their interaction with other processors, and it comments on the significance of Microsoft's OS/2 workstation operating system and of IBM's recent systems application architecture (SAA) announcements.

By comparing users' requirements with the technical opportunities and with the obstacles, the report is able to predict the most likely form of workstations in the future. (In the context of this report, 'future' means in five years' time.)

Finally, the report describes the responsibilities that systems departments have to workstation users and shows how these responsibilities will need to change as the role of the workstation changes. In particular, the report discusses technical policies for workstations and the need to integrate the workstation support unit with the rest of the systems department.

The report concludes that the personal workstation will become an essential element of an organisation's systems architecture. It is therefore directed both at the head of information systems and at those staff who are currently dealing with workstation users.

In Chapter 2, we discuss what users themselves want from personal workstations and we construct a baseline of user requirements against which the suppliers' offerings can be judged. Chapter 3 describes the development in personal workstation technology and software that will impact the marketplace in the next five years, and compares these with the user requirements' baseline. In Chapter 4, we combine the users' views and perspectives with the suppliers' ideas and promises, and predict the likely form of the personal workstations of the future. Finally, in Chapter 5, we discuss the implications of our predictions for Foundation members, their technical policies for workstations, and their support philosophies.

# Chapter 2

# Users' requirements for personal workstations

The behaviour of computer users has always both intrigued and frustrated the computer suppliers — and probably always will. This is especially so in the area of personal workstations — suppliers' predictions have consistently been incorrect. According to predictions made not so many years ago, by 1988 the following events should have come to pass:

- Dumb terminals would no longer be used. In fact, nearly 70 per cent of all personal workstations are still dumb terminals.
- There would be a workstation on the desk of each white-collar worker. Our research shows that, in reality, Foundation members average about one personal workstation per three-and-a-half white-collar employees.
- Technical policies would be geared to using an integrated range of workstations and office systems from a single supplier. In reality, two-thirds of the organisations in our research operate a multisupplier policy and select specific products for specific needs.
- Multifunction workstations, where a single terminal can handle and integrate data, text, voice, and image, would be in widespread use. Today, however, the typical Foundation member has much more limited multifunction requirements. All that is required in the typical Foundation member is the ability to handle word processing and spreadsheets and to be able to download data from corporate systems.
- Most office staff would be communicating electronically, both internally and with the outside world. Our research showed that the reality is very different. Less than one-tenth of all workstations are used for electronic mail, for example.

Our research, however, suggests that the situation is now changing rapidly. By 1993, most workstations will be intelligent and will be linked into the organisation's information-processing network. Most workstation users will wish to be able to interact with data held on a variety of processors (internal or external), to communicate with each other, and to use their workstation for several different functions.

We believe that the disparity between suppliers' predictions and the actual use made of workstations arises from the fact that users' requirements have, so far, been modest. There are two contributory factors to this situation. The products themselves have had shortcomings, and the systems department has often imposed restrictions on the uses that can be made of workstations. In seeking to determine from the users themselves just what they want from personal workstations — now and within the next five years — we therefore sought to identify the extent to which products and internal systems-department policies constrain the uses that can be made of workstations. Accordingly, our research asked three questions:

- What is the penetration of each type of personal workstation now, and what is expected in 1993, and why? The answers to this question showed that the trend is firmly towards much greater use of linked intelligent workstations.
- What are the functions performed on each type of personal workstation now, and expected to be performed in five years' time, and why? The answers showed that there will be a greater demand for multifunction workstations.
- What are the shortfalls in products (hardware and software) and the restrictions in internal policies that are preventing desirable functions from being performed effectively? The answers showed that the major concern of user organisations was ease-of-use.

One difficulty in answering these types of questions is that users will assume that their future use of workstations will be similar to today's use, but more frequent. However, user requirements and working practices can be changed fundamentally, and at very short notice, by technical innovation (like spreadsheet software on the personal computer, for example). We therefore explored two other topics with users:

- The influence that recent developments (like desktop publishing, expert systems, hypertext, and so on) will have on the way that personal workstations are used.

— The business significance of the research into screen design and resolution, image handling, speech input, and so forth.

From our analyses of the answers to the three questions, and from the discussions about recent developments and research innovations, we have been able to produce a user requirements baseline for personal workstations against which to judge the suppliers' offerings — both now and in the future. This we do in Chapter 3.

First though, we set out the results of our user research.

## THE TREND IS TO LINKED INTELLIGENT WORKSTATIONS

Our research into workstation types and penetrations (which is detailed in the appendix) produced three main findings:

— Over the next five years, the Foundation member organisations we interviewed are expecting only a modest overall growth in the total number of personal workstations. However, during this period, there will be a substantial move away from dumb terminals and standalone personal computers to linked intelligent devices.

— Beyond five years, the use of standalone personal computers will decline to zero, but dumb terminals will continue to be used, particularly in the data-entry departments of organisations like banks and insurance companies.

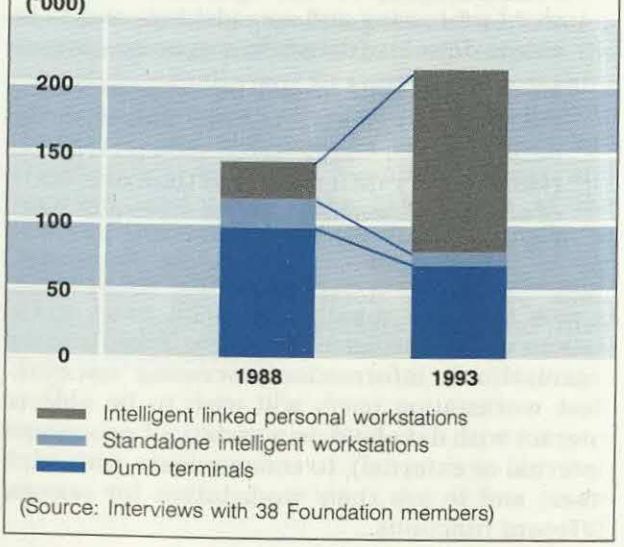
— By 1993, many organisations will have one personal workstation for every two white-collar employees, and they do not believe that the penetration of workstations will increase beyond this level.

This last finding is in marked contrast to the research for the previous Foundation Report (Communications Infrastructure for Buildings), where most members responding to the questionnaire for that report told us they expected one workstation per white-collar employee within five years. We have compared the two sets of responses and have found that different people in the same organisation are often making very different predictions about the penetration of workstations. In general, the communications manager responded to the earlier report, and users and information-centre managers were questioned for this report. It would appear that the communications manager is often assuming a higher penetration of workstations than his or her user colleagues are. However, the differences may be accounted for by the fact that the focus of the earlier report was on main offices and headquarters offices, where workstation penetration is likely to be high. In the research for this report, we focused on workstation penetration throughout the whole organisation, where a lower overall penetration is more likely.

The findings for this report are supported by discussions we had with 44 organisations from nine countries. When we carried out the research, these 44 organisations had installed more than 145,000 personal workstations and were expecting that number to increase to 215,000 by 1993. More important than these absolute volumes is the changes in proportions of the different types of workstation. Figure 2.1 shows the proportion of each type in 1988 and predicted for 1993. (The data shown in Figure 2.1, and in other figures in this report, was gathered during detailed interviews with 38 of the organisations. The other six organisations attended a focus group.) At the beginning of 1988, the predominate type of workstation was dumb terminals — over two-thirds of all personal workstations were of this type. Of the remainder, there was a fairly even split between standalone and linked intelligent devices. By 1993, however, the situation is expected to reverse completely. Foundation members expect two-thirds of all workstations to be intelligent. Even more significant is the fact that the vast majority of intelligent workstations are expected to be linked.

The number of linked intelligent devices is set to grow by a factor of five over the next five years, whilst the number of dumb terminals and standalone intelligent terminals will decline by nearly 30 per cent and 60 per cent respectively. Thus, although the total number of personal workstations will increase by just under 50 per cent

**Figure 2.1 Over the next five years, there will be a major shift to using linked intelligent personal workstations**



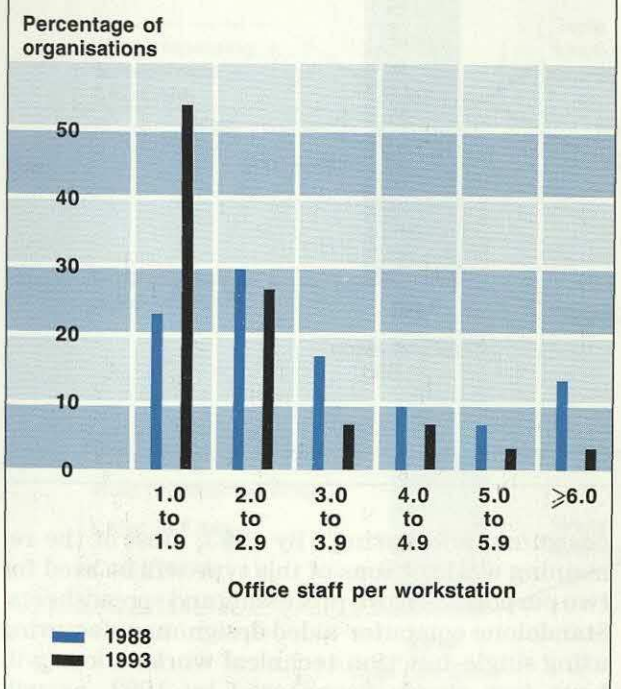

(Source: Interviews with 38 Foundation members)

over the next five years, substantial numbers of workstations will be purchased during this period as organisations switch to using linked intelligent devices.

Looking still further ahead, we expect that the use of standalone personal computers will disappear altogether, but that there will be a continuing need for dumb terminals. Most of the organisations we interviewed believe that dumb terminals are (and will continue to be) the most cost-effective devices for dedicated data entry. However, a few organisations believe that the cost differences are so marginal that all dumb terminals will eventually be replaced by linked intelligent workstations. The results of our own analysis of future workstation costs (which are set out in Chapter 4) support the majority view.

Figure 2.2 shows the penetration of workstations in 1988 amongst white-collar employees in the organisations we interviewed, and the penetration predicted for 1993. The figure shows that the penetration is expected to almost double during this period. In 1988, on average there is one personal workstation for every three-and-a-half white-collar employees. By 1993, there is expected to be one personal workstation for every two white-collar employees, and, interestingly, the majority of organisations we spoke with do not expect the penetration to increase significantly beyond that.

**Figure 2.2 Average penetration of workstations will increase from 1 per 3.5 office staff to 1 per 2 office staff between 1988 and 1993**




(Source: Interviews with 38 Foundation members)

However, nearly two-fifths of the organisations do expect to have one personal workstation for each white-collar employee by 1993. The remaining three-fifths believe that it will never be cost-effective to install personal workstations on this scale.

## WORKSTATIONS WILL BE USED TO PERFORM A GREATER NUMBER OF FUNCTIONS

The results of our survey into the functions that users perform, and will wish to perform, on personal workstations are detailed in the appendix. In summary, the results show that:

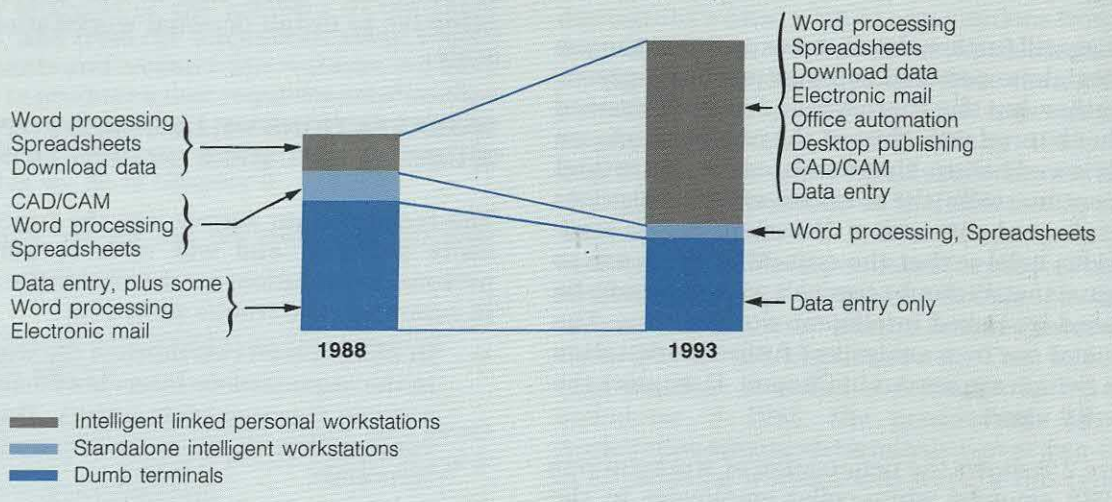
- In 1988, at least two-thirds of the workstations in the organisations interviewed are used for a single function (data entry). This result is consistent with the predominance of dumb terminals.
- By 1993, nearly two-thirds of all workstations are expected to be used for three or more functions. Word processing, spreadsheet calculation, and downloading data (from a host processor for spreadsheet or other modelling purposes) will be the predominate functions — but there will also be significant growth in the use of electronic mail and other office automation facilities as additional (rather than standalone) functions.
- Personal workstations will also increasingly be used for desktop publishing, especially in conjunction with computer-aided design and manufacturing applications.

These findings reflect the changing mix of workstation types discussed above and, as Figure 2.3 overleaf shows, the trend towards multi-function use mirrors the trend to linked intelligent devices. However, to understand fully the relationships between workstation type and usage, we need to examine the findings for each workstation type in more detail.

### DUMB TERMINALS

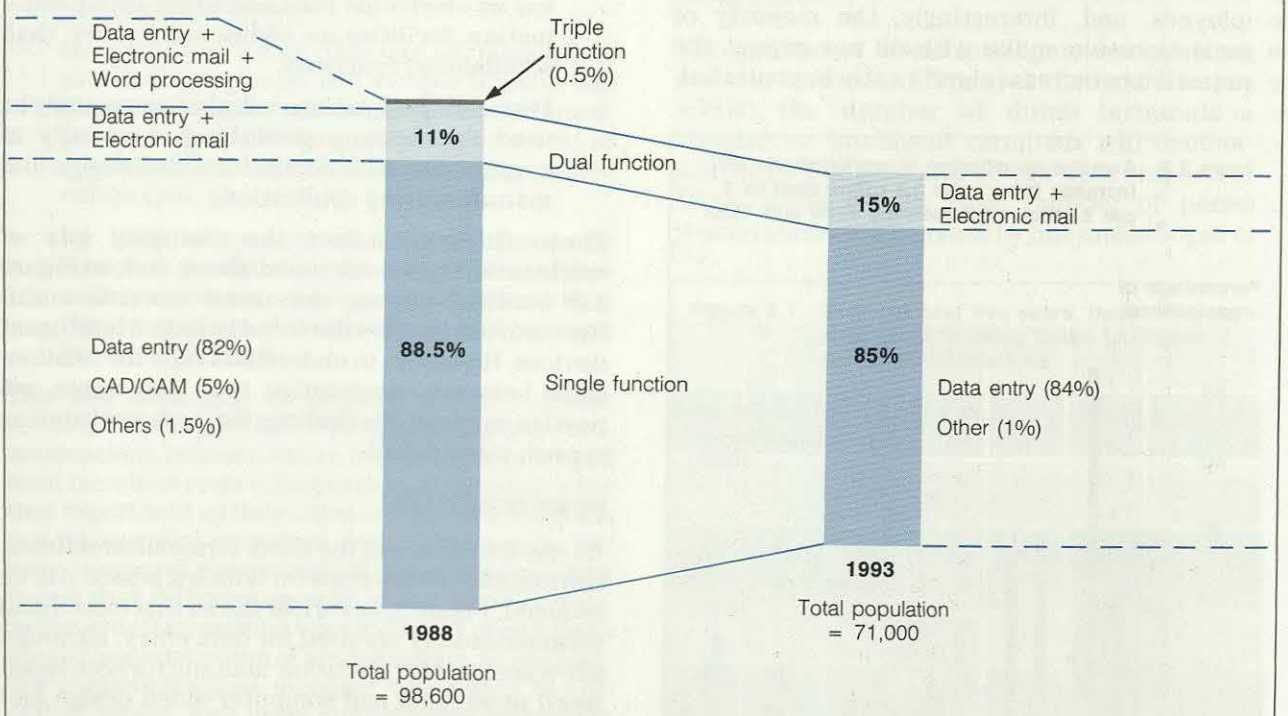
As the dominance of the dumb terminal diminishes, the number of functions for which it is used will be reduced. Figure 2.4 overleaf shows that most dumb terminals today are used for data entry, although a few are used for electronic mail and for host-based word processing and computer-aided design and manufacturing. By 1993, host-based word processing and computer-aided design and manufacturing will have disappeared, although a few of the remaining dumb terminals will be used for electronic mail as well as for data entry. The dominant application for dumb terminals in 1993 is still expected to be data entry — although the number of dumb terminals installed will have reduced substantially.

**Figure 2.3 Linked intelligent personal workstations will become the multifunction device**




(Source: Interviews with 38 Foundation members)

**Figure 2.4 By 1993, dumb terminals will be used mainly for a single function — data entry**




### STANDALONE INTELLIGENT WORKSTATIONS

The number of standalone intelligent workstations (PCs) is also expected to decline, as is the number of functions for which they are used. Today, as Figure 2.5 shows, a few standalone intelligent workstations are used for three functions (word processing, spreadsheets, and computer-aided design/manufacturing). By 1993, most of the remaining workstations of this type will be used for two purposes — word processing and spreadsheets. Standalone computer-aided design/manufacturing using single-function technical workstations will have just about disappeared by 1993, as will standalone word processing.

### LINKED INTELLIGENT WORKSTATIONS

In contrast to dumb terminals and standalone intelligent workstations, the number of linked intelligent workstations installed is set to grow rapidly during the next five years, as is the number of functions for which they will be used (see Figure 2.6 overleaf). Not only will the overall number of functions performed on linked intelligent workstations increase (with desktop publishing being added to the list of 1988 functions), but the number of functions performed at any one workstation will increase substantially as well.

#### *Growth in individual functions*

In terms of the proportion of workstations used for a particular function, the organisations we interviewed expect more linked intelligent workstations to be used for electronic mail and office automation, whilst a smaller proportion will be used for data-entry tasks. By 1993, 42 per cent of linked intelligent workstations will be used for electronic mail, compared with 14 per cent in 1988. And 17 per cent will be used for office automation functions, compared with just 1 per cent today. Today, 46 per cent of linked intelligent workstations are used for data-entry tasks; by 1993, the proportion is expected to fall to 18 per cent.

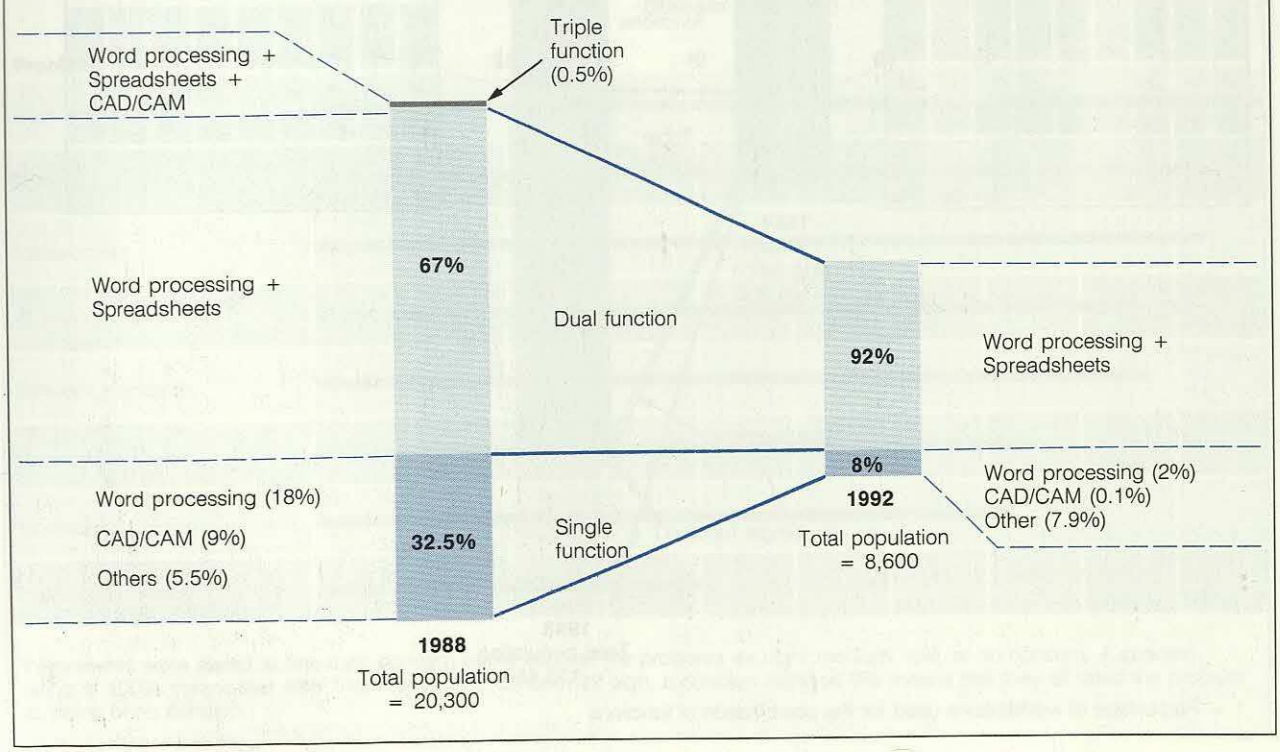
We believe that the projected use of linked intelligent workstations for electronic mail understates the likely growth. During the next five years, many organisations will reach the critical mass of workstations that triggers a dramatic increase in the use of electronic mail. By 1993, we therefore believe that the majority of linked intelligent workstations will be used for electronic mail.

The growth in the use of linked intelligent workstations for office automation will come from much greater use being made of facilities such as diary and meeting management. Several of the organisations we interviewed predicted that the use of such facilities would increase considerably during the next five years.

By 1993, desktop publishing is also expected to be a well-established application on 11 per cent of linked intelligent workstations, with many (but not all) desktop publishing applications being integrated with computer-aided design and manufacturing applications.

We were surprised that none of the organisations we talked with was predicting that expert systems would form a significant class of application for linked intelligent workstations. We believe that this stems from the fact that, in 1988, most organisations still regard expert systems as experimental. However, the recent Foundation Report on expert systems (Number 60, published in October 1987) predicted that by 1993 many organisations would be using expert systems. We expect that many of these will run on linked intelligent workstations.

**Figure 2.5 By 1993, standalone intelligent workstations will be used mainly for two functions — word processing and spreadsheets**



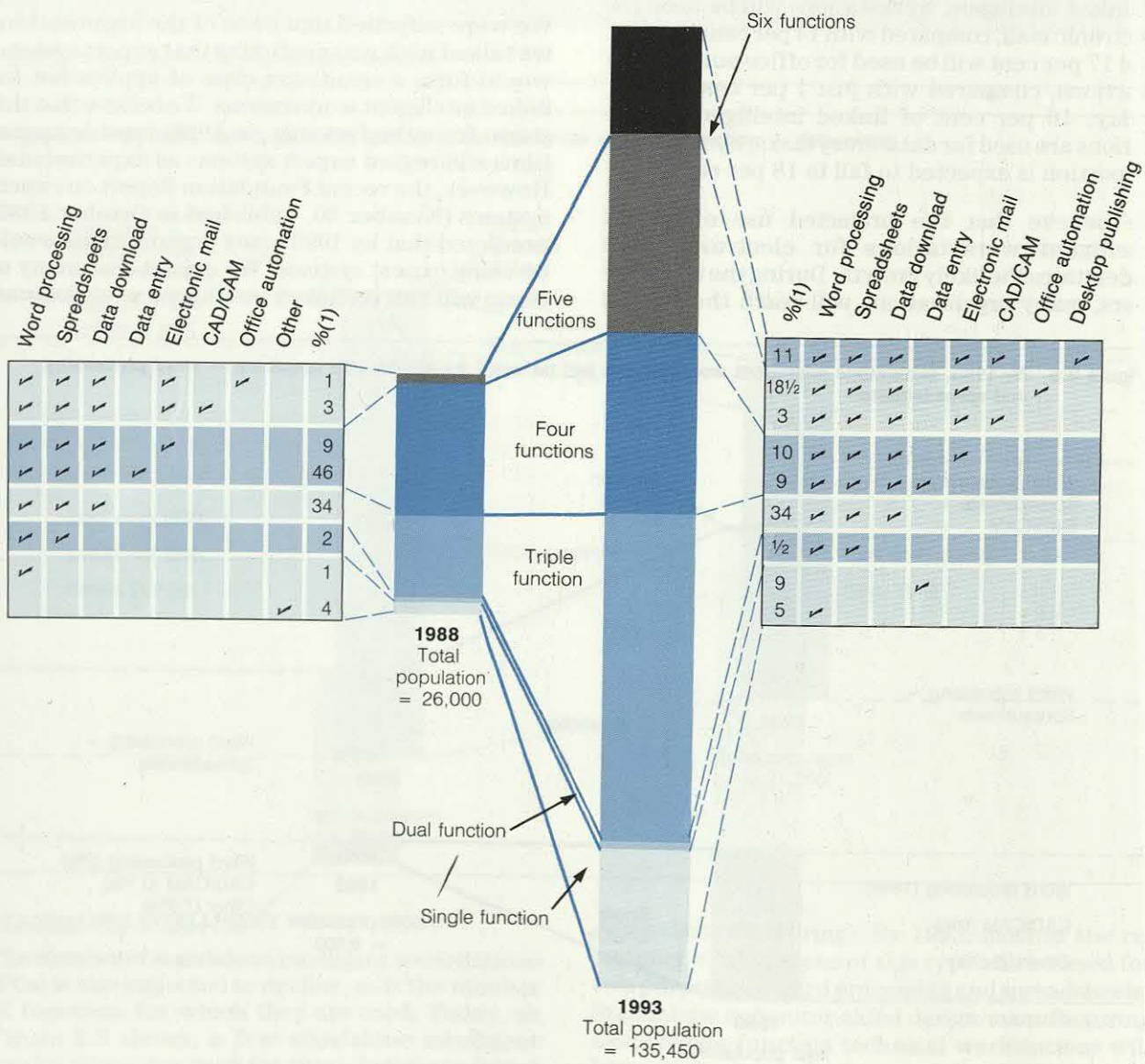
***Growth in multifunction use***

In the past, organisations have usually selected specific products for specific purposes. Thus, DEC equipment may have been installed for office automation, IBM for personal computers, and Apollo for technical workstations. Our research suggests that this trend is changing and that the growth in individual functions described above is accompanied by a desire to carry out as many functions as possible on the same device. Figure 2.6 shows that there will be a significant increase in the number of functions that will be performed at one workstation in 1993. Nearly a third of all linked intelligent workstations will be used to carry out five or more functions. By contrast, in 1988 less than five per cent are used for more than four functions. Figure 2.6 also shows that by 1993, some linked intelligent workstations are expected to be used for six functions — word processing, spreadsheets, downloading data, electronic mail, desktop publishing, and computer-aided manufacturing/design. At the other extreme, some growth in single-function use is expected as linked intelligent workstations increasingly replace dumb terminals for dedicated data entry.

## EASE-OF-USE IS THE MAJOR USER CONCERN

So far in this chapter we have shown that, in user organisations, the trend is away from dumb terminals

**Figure 2.6 As the number of linked intelligent workstations increases, more functions will be performed on the same device**




1 = Percentage of workstations used for the combination of functions

and standalone intelligent devices and towards linked intelligent workstations, and that workstations will be used to perform a greater number of functions. In theory, suppliers should have little difficulty in providing products that allow workstations to be used in this way. In practice, however, Foundation members told us that current products are not designed in a way that makes it easy to satisfy even today's user requirements.

Workstation users wish to be able to access relevant data held on any system (internal or external), but especially on mainframe systems, in as simple and as inexpensive a manner as possible. In particular, they want the method of interaction to be the same, regardless of the types or makes of processors being accessed or the software they run. They do not want to have to learn that in some situations they need to type 'exit', and in others have to type 'log off' to achieve exactly the same effect. In other words, they want workstations to be easy to use, particularly in terms of the user interface.

At the beginning of 1988, ease-of-use difficulties were arising from a lack of common interfaces, a lack of software and keyboard standards, and from continuing problems with interworking and communications. Figure 2.7 shows that the organisations we interviewed rated ease-of-use as their most important concern, with all of them rating their concern as 'high'. Ease-of-use problems were also identified as the underlying concern behind many of the other workstation problems discussed. (User organisations were asked to rate each difficulty as being of high concern, medium concern, low concern, or no concern.)

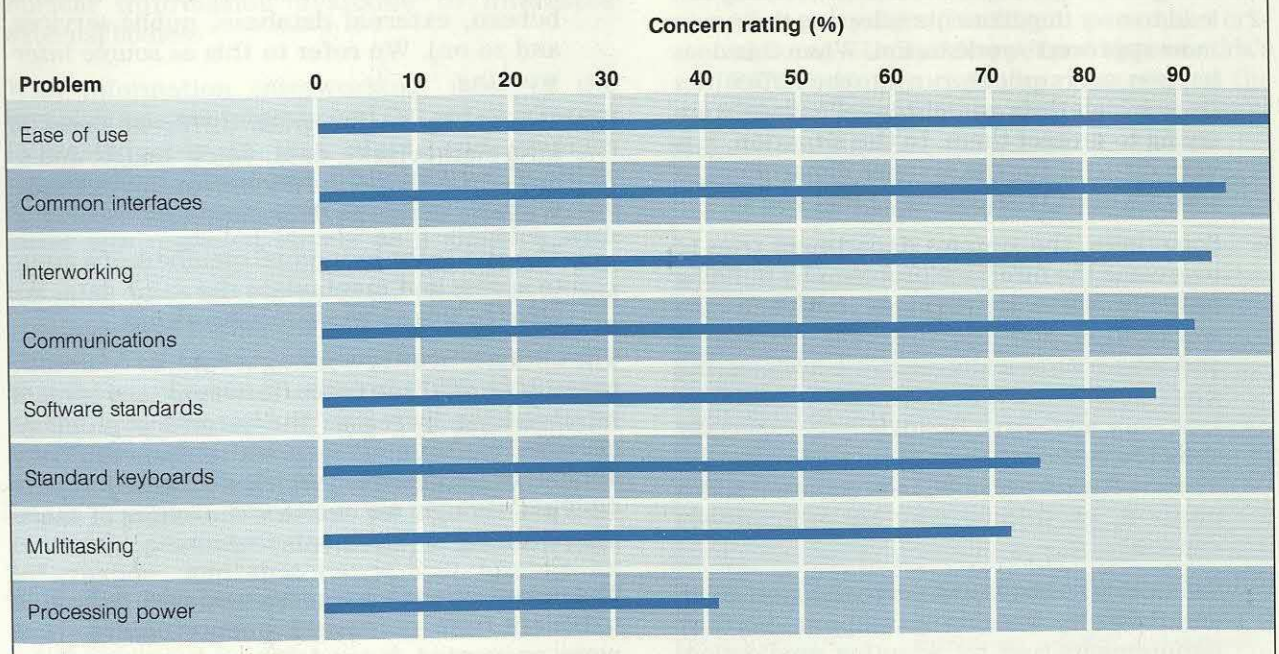
If suppliers are not able to provide easy-to-use workstations that satisfy today's users' requirements, what hope do they have of satisfying the 1993 requirements? Unless there is a major change of direction by the suppliers, there will be an even greater variety of emulators, code convertors, communications layers, host operating systems, bespoke interworking 'fixes', and so on — all of which will add to the ease-of-use difficulties.

To understand both the nature and extent of workstation users' concerns expressed in Figure 2.7 we need to examine the underlying technical needs behind their apparently straightforward requirements, and the thinking behind their attitudes to some of the more recent workstation developments. The appendix shows how we conducted this examination. Here we discuss our findings.

#### LACK OF COMMON INTERFACES

In 1983, in Foundation Report 35 — Multifunction Equipment, we identified the need for interfaces that are standard across a range of applications, even when the workstation is being used to access proprietary systems such as a host mainframe or a public videotex service. We pointed out that this need would become much more important once

**Figure 2.7 The most important user concern is ease of use. It is also the underlying cause of many of the other concerns**




Interviewees were asked to rate their concern about each of the problems as high, medium, low, or no concern. A concern rating of 100% means that all of them rated their concern as high; a concern rating of 0% means that they all rated the problem as being of no concern.

workstations had to be used by most office workers, rather than by those who had specific applications requirements and the enthusiasm to use the workstations despite their shortcomings. In 1988, we find that our prediction of the growing importance of standard user interfaces was right, but that there are still no globally accepted workstation standards for the user interface, for programming, for database or graphics purposes, for network access, or for printing. (An example of a user interface is the so-called WIMP interface — windows, icons, mouse, and pull-down menus.)

Workstation users wish to be able to interact with a workstation in as simple and consistent a manner as possible regardless of the equipment and software in use, or whether it is local or remote. The lack of common interfaces frustrates this desire and was the most severe ease-of-use problem in our survey. The severity is reflected by the ways in which organisations have tried to minimise the interface problems:

- In some organisations, the systems department has imposed a very rigid policy that restricts the products that can be used. Such a policy is likely to fail for two main reasons. First, the next generation of a product may not necessarily conform to the standards of its predecessor. Second, the systems department may not have a sufficiently intimate knowledge of the peculiarities of each product's interfaces to derive a policy that avoids the interface difficulties. In any case, a very rigid policy usually results in mediocre workstations being chosen, which satisfies no one and can lead to user departments selecting their own 'non-approved' workstation. When this does happen, users quickly run into the difficulties from which their computer colleagues were trying to protect them. In this situation, it is very difficult for the systems department to restrain itself from saying "I told you so."
- Sometimes, the systems department tries to overcome the interface problems by building bespoke software bridges between the workstation and the different systems it accesses. With as many bridges as systems, the single-function dumb workstation begins to look very attractive financially — especially since the cost of changing bridges to cater for a new software package, telecommunications protocol, or printer may be prohibitively expensive.
- Sometimes, users try to make the most of an unsatisfactory situation by compromising their requirements and by adopting application-specific working practices. Such an approach requires continuing training, intellectual agility (which command this time?), and great tolerance. We believe that this is one of the reasons why most senior executives do not use personal workstations, and why most middle and junior managers quickly learn to limit the use they make of workstations and the imagination with which they use them.

The overall result is that, in many organisations, users are not making the most of the investment made in workstations. This result is borne out by recent surveys in the United States, whose findings suggest that there has been no increase in white-collar productivity as a result of workstation usage. These findings are causing some organisations to review very seriously their attitudes to future workstation investment. In response, some suppliers suggest that the surveys were probably not defining productivity properly and that, in any case, enterprises should be prepared to change their organisational and working practices in response to the opportunities provided by workstations. Fortunately, as we discuss in Chapter 3, other suppliers are taking a more sympathetic view to the common interface problems and will be actively working to improve the situation over the next five years.

#### INTERWORKING DIFFICULTIES

There are many different definitions of interworking. Discussions with Foundation members suggested three that are particularly important in the context of personal workstations:

- The ability for a single user to access and manipulate data from different sources (local, distributed, mainframe, file server, external bureau, external database, public services, and so on). We refer to this as *source interworking.*
- The ability to integrate different types of information (text, data, voice, image, and so on) — in a compound document, for example. We refer to this as *information interworking.*
- The ability for individual members of a group to access and manipulate the same data. We refer to this as *group interworking.*

The ultimate in interworking would, of course, be to combine all three types. However, any level of interworking increases the interface problems discussed earlier, and brings with it a new difficulty — telecommunications, which we discuss on page 12. First, though, we examine the extent of users' interworking requirements.

The organisations we interviewed wish to be able to benefit from interworking opportunities — but were prevented from doing so because of the technical complexities or the cost of special-purpose software and hardware solutions. Most organisations rated their concern about interworking

as 'high', suggesting that there are many urgent business problems or needs that could be resolved if only interworking was easy to achieve. In practice, however, the actual requirements are fairly limited.

The bulk of user requirements were in the source-interworking category. Many organisations talk of the need to provide users with a 'single user image', by which they mean the ability to use the same personal workstation as the entry point into any processor on the organisation's network. In fact, only a third of the organisations we spoke with mentioned this as a specific requirement — the remaining two-thirds only require the ability to download data from corporate mainframe systems to PCs. Many of the organisations that do want to use the personal workstations as the entry point to any system have a global interworking requirement because they operate multinationally. This is especially true in security-dealing firms where a dealer must be able to use his or her workstation to assess the risks and potential rewards of a particular deal by accessing information from all over the world.

Access to external databases is also an important requirement in manufacturing companies involved in buying commodities. Another source-interworking example was provided by the United Kingdom Central Electricity Generating Board. This organisation described the need for engineers to use their personal workstations to access external nuclear information; it also has a reciprocal statutory requirement to make its own nuclear information available to interested external bodies.

With information interworking, most of the organisations we interviewed (80 per cent) were interested only in text, data, and graphics interworking. There was little interest in either computerised image or voice information — the latter was regarded largely as a gimmick with limited commercial relevance; the former was regarded as desirable in some very specialised circumstances — some of which are highlighted in Figure 2.8. In either case, organisations perceive that there are serious technical difficulties (more at the host end than at the workstation) to be overcome before any viable products will be available that will allow interworking to include image or voice information. We believe this view is unduly pessimistic for some types of image information, and that image will become an important element of interworking sooner than many organisations believe.

Turning to the need for group interworking, we found very few organisations that had adopted the work-group philosophy. Two organisations talked about the need for multi-user spreadsheets, where a spreadsheet could be passed from one personal workstation to another for further processing; another organisation spoke of the desirability of allowing a user to see changes to a database as they are made by another user. Significantly, all three organisations are in the financial-services sector where up-to-the-second awareness of changing situations is critical. A fourth organisation, in the manufacturing sector, told us how its engineers are responsible for technical reference manuals, and its technical authors are responsible for user manuals. The interworking problem was how to transfer the reference material, which is created on an Apollo technical workstation, to a Siemens word processor in a format with which the technical authors could then work. All of the other organisations we interviewed had no specific group-interworking requirement, although several of them mentioned applications in the 'it would be nice to have' category.

In all three interworking categories, once the communications problems (which are described in the next section) have been resolved, the application interworking problem is revealed and manifests itself in many ways:

— The data structures on mainframes, distributed processors, and personal workstations are entirely different — as are the software routines that manage them. As a result, the data may be transmitted to the workstation in an inappropriate format. There are some database products that are claimed to be compatible across a range of mainframes and microcomputers (intelligent personal workstations) — Unisys' Mapper and Mathematica's RAMIS are two examples. However, at the detailed level such products are not always

**Figure 2.8 Some Foundation members' requirements for computerised image information**

| Organisation | Requirement |
|---|---|
| A major airline | Capture hand-written cabin crew flight reports |
| A large manufacturing company | Capture and store documentation relating to corporation tax in accordance with statutory requirements |
| An insurance company | Capture hand-written assessors' reports |
| Local government | Access and manipulate digitised maps for planning purposes |
| Local government | Enable museum staff to capture and access visual material for cataloguing, research, and presentation purposes |
| An engineering company | Capture and manipulate free-hand illustrations |

absolutely compatible, and in any case, they are not the most widely used.

- The methods used for storing numeric fields vary between mainframes, distributed processors, and personal workstations.
- There is an inevitable imbalance between the volume of data available at a mainframe or distributed processor and the capacity of a workstation.
- Corporate databases are very complex, and workstation users have difficulty in understanding what is available in the databases, how it relates to what they are doing, and how to exploit the databases without causing security, data privacy, or authenticity problems. (We return to this particular group of problems in Chapter 5 on page 42.)

In most organisations, the systems department has attempted to overcome these application-level interworking problems in a variety of ways:

- Simplified data models are made available to all personal workstation users.
- Operational data is transferred periodically to a simplified file or relational database that workstation users are permitted to read (but not write to). The transferred data is selected according to criteria generated by proprietary software that sends appropriate commands to the mainframe, and converts the retrieved data to a format suitable for the workstation application.
- Preprocessed extracts of operational data are created (perhaps using conventional report-generation software) at a mainframe or distributed processor and are transferred to the workstation where they are received by an appropriate software routine (proprietary or bespoke). Again, the retrieved data must be converted to a suitable format for the workstation application.

In theory, any type of interworking is possible, provided the systems department has sufficient expertise and resources to build the bespoke, user-specific bridges required to interlink different systems. This approach, however, is very expensive and time-consuming, and is not easy to achieve even among different software environments from the same computer suppliers. For example, many IBM mainframe installations run CICS, IMS, DB2, and TSO, and some workstation users want to be able to interwork with all four. It is possible to achieve this, but the effort involved in doing so is enormous.

#### TELECOMMUNICATIONS PROBLEMS

The next most important concern expressed during our research by user organisations was telecommunications problems. It is clear that communications problems are a significant factor in making workstations difficult to use. As discussed above, the main user requirement is to link personal workstations with mainframes for data-transfer purposes. This apparently straightforward requirement can be difficult to achieve because of compatibility problems between the types or makes of equipment at each end of the link and because of the restrictions imposed by the networks used for the links.

Many of the difficulties stem from the fact that most organisations have a variety of equipment from several different suppliers. Over two-thirds of the organisations we interviewed have a multivendor policy for processors and a separate and different multivendor policy for workstations. Figure 2.9 illustrates the range of equipment that has been installed in just one organisation over the past few years. The number of possible interworking permutations, each involving a bespoke set of protocol conversion, code conversion, and synchronisation routines, is considerable.

Some organisations have solved these problems by implementing very expensive and highly intelligent local area networks with sophisticated gateways into wide-area communications. Others have adopted a less-expensive and more singular approach, creating separate networks for groups of similar devices. Another approach that is still used by a surprisingly large number of organisations is to physically unplug the workstation from one network and plug it in to another.

Communications problems of this type have existed for many years — they are in fact identical to the

**Figure 2.9 A typical history of choosing workstation suppliers**

| Date | Event | Suppliers |
|---|---|---|
| 1978 | Olivetti word processors installed in all UK branches; international division standardised on Wang | Olivetti and Wang |
| 1984 | Standalone IBM PCs chosen as the replacement word processors | Olivetti, Wang, and IBM |
| 1984 | Apple Macintosh the predominant personal computer | Olivetti, Wang, IBM, and Apple |
| 1985 | Linked IBM PCs chosen as the Macintosh replacement | Olivetti, Wang, IBM, and Apple |
| 1986 | DEC chosen as the preferred office systems supplier | Olivetti, Wang, IBM, Apple, and DEC |

Changes in technical policy always increase the number of suppliers because it takes many years for the superseded equipment to be replaced

problems that OSI and SNA set out to solve. The main difference is that they now affect the working lives of many more people — many of whom were told by the suppliers that using a personal workstation is simple and straightforward.

The most common technique for linking personal workstations to mainframes or distributed processors is to use an appropriate emulation product that also converts the mainframe EBCDIC standard to the ASCII standard required by most intelligent personal workstations. Most popular products come in the form of boards that plug into extension slots at the back of the workstation. Other products emulate network controllers or cluster controllers and, hence, facilitate access across public networks. The organisations interviewed commented that all these products are too expensive, especially since each workstation requires an individual board and each board handles only one emulated device. Further expense is necessary for the software required to convert the transferred data into the format required by personal workstations, and for the physical cabling costs. One company told us that, in its experience, cabling costs added a further third to the price of the basic workstation and that it was looking forward to the advent of infra-red communications. (Foundation Report 62 dealt in detail with the subject of wiring costs.) Other organisations said they would like workstations with built-in communications interfaces based on OSI standards, and supporting Ethernet, Token Ring, SNA, bisynch, and so on.

#### LACK OF SOFTWARE STANDARDS

User organisations frequently find that proprietary applications software that matches their business requirements cannot be used because it is not compatible with their existing applications software or operating systems. It is therefore not surprising that the lack of common software standards was the next most severe ease-of-use problem identified in our survey of user organisations.

Most organisations have standardised on a particular operating system for their intelligent workstations (PCs). Unfortunately, many existing PC operating systems are little more than sets of software routines that handle some limited operating-system functions. It is important to realise what these so-called operating systems do not handle. MS-DOS, for example does not handle application-software integration, or communications, or graphics, or functions such as buffering to improve the performance of text-processing software. As a result, applications software has to perform the functions that should really be performed by the operating system (as much as 70 per cent of the code in a typical workstation application may be for functions that would be carried out by the operating system in a larger system). It is not surprising that different application developers take different views on how these functions should be handled — and the consequence is a substantial lack of software standardisation.

Most users are made aware of the lack of software standards when they try to pass data from one application package to another. In many organisations, the systems department writes special 'black magic' software to achieve the necessary integration on a package-by-package basis. This software may need to be very sophisticated, dealing, for example, with the incompatibility between sets of control characters for text, graphics, and printers — a particularly important document-interchange requirement.

Most of the organisations we interviewed were fairly uncritical of the quality of the software they have to work with on their intelligent workstations. Three organisations wanted better graphics facilities, and two wanted more powerful database and query packages. Only one company complained about the lack of a natural-language interface, and only one complained of software errors. We believe the complacency shown by the organisations that participated in our research stems from the pessimistic air of resignation of many workstation users, and masks the real difficulties caused by the lack of software standards.

There is one software issue that many Foundation members are very concerned about and that is whether to switch from their current intelligent workstation operating system standard to some other. Some organisations are wondering whether to switch from MS-DOS to Unix; others are wondering what to do about OS/2. We review the developments of workstation operating systems in Chapter 3, in particular the likely significance of OS/2.

#### LACK OF STANDARD KEYBOARDS

The next most important ease-of-use concern expressed by user organisations was the lack of standard keyboards. Most organisations expect the keyboard to be the main form of workstation input for at least the next five years. There is, however, some interest in voice input as an alternative, although voice input is usually positioned as 'it would be nice to have', rather than as a definite requirement. Figure 2.10 overleaf gives some interesting examples of users' voice-input requirements we encountered during the research. There is little interest in touch screens, except perhaps in dealing-room operations where input speed may be crucial. Even here, touch screens may not be the preferred input method; dealers in one securities

**Figure 2.10 Some Foundation members' requirements for voice input**

| Organisation | Requirement |
|---|---|
| Local government | Enable social workers to input their reports |
| A major food manufacturer | Allow sales staff to report on new leads and on the results of sales calls |
| Local government | Capture court and council proceedings |
| Manufacturer | Overcome senior managers' reticence to use keyboards |

company have begun to complain about arm-ache caused by the sustained awkward physical position.

Many organisations believe that the physical layout of the keyboard is the most critical factor contributing to ease-of-use difficulties. Users want to be able to use their workstations in as simple a manner as possible and always in the *same* manner. Different keyboard layouts make it impossible to do this. The layout of keyboards continues to be different from one workstation to another — particularly in terms of the use of function keys. Even the keyboards from the same supplier are not necessarily the same (the IBM basic PC differs from the enhanced PC, and the PC-AT is different again). These differences are significant in the eyes of users and *do* matter because:

- Organisations replace their existing workstations with the most up-to-date products from their preferred vendors.
- Professional staff use more than one workstation because of the interworking and communications problems mentioned earlier.
- Staff move from one department to another and have to use different workstation products when they move.

On the other hand, some organisations believe that the keyboard should be designed to suit a specific function and they would therefore expect layouts to vary between computer-aided design and manufacturing workstations and word processors, for example. Because of the trend towards performing more functions at the same workstation, there could be a need to select a keyboard layout under appropriate software control.

#### LACK OF MULTITASKING FACILITIES

Workstation users wish to decide their own working patterns without being constrained to particular practices by the limitations of their workstations. Over and above the concerns already discussed, the organisations we interviewed considered that the lack of multitasking facilities at the workstation is a drawback and contributes to the overall ease-of-use problem.

From the workstation user's point of view, the multitasking need appears to be mainly one of convenience rather than a genuine need to be working on several tasks at once. In particular, multitasking is seen as a way of reducing the amount of time wasted whilst waiting for a transaction to be completed by allowing the user to get on with something else in the meantime. One company wanted to run several spreadsheets currently on the same workstation, passing intermediate results from one to another, but generally the multitasking requirement was more straightforward:

- To be able to print a document or establish a mainframe emulation link, or transmit a message via the electronic mail system whilst working on a spreadsheet.
- To permit lengthy calculations to be progressed 'in the background' whilst receiving electronic mail messages or inspecting the latest information from an external service.

In practice, many of the requirements identified earlier (peer-to-peer communications, text-and-data interworking, and so on) will be difficult, if not impossible, to achieve without multitasking facilities, and it is clear that multitasking is a necessary feature for all network servers. It is, therefore, also clear that most organisations have yet to appreciate that multitasking is not just a means of making life more convenient for the workstation user. Multitasking will be an essential element of the workstation of the future.

#### LACK OF PROCESSING POWER

Only a quarter of the user organisations we interviewed said they had an urgent requirement for more processing power in their workstations. Figure 2.11 lists some of the applications where more power is required. Other organisations ranked additional processing power in the 'nice to have' category, and a third of all those interviewed felt that the power available in existing intelligent workstations was more than enough. As a consequence, additional processing power was rated as being of medium or low concern by most of the interviewees.

More concern was expressed about the lack of memory or data storage — with most organisations complaining that the limit of 640k random-access memory on many intelligent workstations was too low. Others illustrated their need for additional storage by describing how spreadsheets had to be divided into smaller chunks, and then had to be re-integrated by specially written software 'fixes'.

**Figure 2.11 Examples of Foundation members' requirements for more workstation processing power**

| Organisation | Requirement |
|---|---|
| Insurance company | Actuarial calculations |
| Engineering company | Stress analysis calculations |
| City regulatory body | Analysis of securities buying and selling patterns |
| Insurance company | Claims analysis |
| Manufacturer | File-server activities |

## USERS' VIEWS OF RECENT WORKSTATION DEVELOPMENTS

So far we have discussed the workstation concerns expressed by user organisations. We now turn to their views on the commercial relevance of recent workstation developments and the business benefits they could bring. Figure 2.12 shows the interest rating given to a range of developments, with desktop publishing being rated the most promising area and portable workstations the least promising. (Organisations were asked to state whether their interest in the development was high, medium, low, or no interest.) Each of these developments is now discussed in turn.

### DESKTOP PUBLISHING

The workstation development that attracted most interest among the organisations we interviewed was desktop publishing. Those organisations that did not express an interest in desktop publishing usually either produce high-volume publications, and doubt that workstation-orientated desktop publishing would be cost-effective, or are veteran users of Apple's Macintosh and wonder what all the fuss is about.

Many organisations expressed a concern that today's desktop publishing software was no substitute for the creative flair of a professional printer, and looked forward to the day when the software was sophisticated enough to be able to advise on layouts and offer suggestions and criticisms. To do this would require printing expertise to be captured in some form of expert system, and for the desktop publishing software to be able to interwork with the expert system.

One Hong Kong-based company identified the need for a different type of interworking — the ability to link desktop publishing workstations to commercial typesetters for mass production.

### DISC-LESS WORKSTATIONS

With the disc-less workstation concept, data is not stored at each workstation. Instead, all the workstations are linked to an appropriate local area network that includes a file server. All data (and software) would be stored at the file server and controlled via professional data-integrity and security practices.

**Figure 2.12 User organisations' interest in possible workstation developments**


Interviewees were asked to rate their interest in each of the possible developments as high, medium, low, or no interest. An interest rating of 100% would mean that all of them rated their interest as high; 0% would mean that they all said the possible development was of no concern.

In our survey, the disc-less workstation concept received a high interest rating, mainly because of the growing concern about data integrity and security and about breaches of software copyright. One international securities company has already adopted this approach and a major public utility is planning to do the same. One-third of the organisations interviewed believe that disc-less workstations will form the basis of their future workstation policy. Where organisations have doubts about the disc-less workstation concept, their concern centres on the adequacy of software currently available for the file servers.

Some of the interviewees suggested that networked disc-less workstations were the most obvious and cost-effective approach for departmental computing, removing the need for departmental minicomputers.

#### HIGH-RESOLUTION SCREENS

The organisations we interviewed rated high-resolution screens as the third most important workstation development. Ten of them have business needs that could benefit immediately from high-resolution screens, and Figure 2.13 gives some examples of their specific requirements. Advocates of high-resolution screens believe that windowing techniques (which allow different sources of information to be observed simultaneously in different areas of the screen) require screen resolutions higher than those available with the extended graphics adaptor (EGA) standard. High-quality graphics also require resolutions better than the EGA standard. One life insurance company felt that higher-resolution screens could help with the eye strain experienced by some of its data-entry operators. On the other hand, many organisations felt that the EGA standard is perfectly satisfactory for most commercial workstation applications.

**Figure 2.13 Examples of applications requiring high-resolution screens**

| Business sector | Requirement |
|---|---|
| Retail | Computer-aided design of shop layout and allocation of shelf space |
| Engineering | Computer-aided design of circuit boards and networks<br>Computer-assisted calculation of metal-fatigue effects |
| Government | Computer-aided tour planning, making use of digitised maps |
| Banking/finance | Simultaneous display of many windows containing different financial information |
| Services | Reducing eyestrain for intensive workstation users |

Some of the organisations that perceived the need for higher-resolution screens linked it with a requirement for larger screens. (Overall, large screens were given a medium interest rating.) Large screens were thought to be particularly relevant for complex windowing, and for displaying plans, circuit diagrams, and maps. Engineering organisations said they wanted A2-size screens, and commercial organisations wanted A4. In both cases, the need is to see on the screen exactly what is wanted, and exactly what will be produced on paper. Two organisations discussed the need for extra-large screens for mass-presentation purposes — interworked, needless to say, with desktop publishing for the preparation of visual aids.

#### ELECTRONIC MAIL

Earlier in this chapter we said that there will be a growing interest in electronic mail during the next five years. The purpose of our detailed discussions with Foundation members was to discover the nature of the electronic mail systems that will be used.

In general, we found the requirements to be rather unambitious. Most organisations have, or are in the process of conducting, electronic mail pilots, and are satisfied with the proprietary products available (except perhaps for the user interface). There were few complaints about the limits imposed on message lengths — in fact, many organisations prefer messages to be shorter. Communications networks are particularly vulnerable to the mischievous use of electronic mail systems — especially broadcast messages. One frequently quoted example is the 'chain' Christmas greeting that was designed in a way such that each time a recipient 'opened' the greeting, new greetings were automatically sent to everyone on his or her distribution lists. The effect on the organisation's communications network was devastating.

Most organisations we interviewed were interested in messages containing text and data (including graphics) only. Four were interested in including voice messages as well to allow off-site employees to input spoken messages into the system (sales staff, inspectors, site-engineers, and so on). Three organisations wanted to include image in their electronic mail systems (for example, an insurance company wished to transmit the images of assessors' reports to relevant workstations via the electronic mail system). One company was enthusiastic about the prospect of using its electronic mail system for teleconferencing, and two others wanted a facsimile input feature for their electronic mail systems.

#### EXPERT SYSTEMS

The recent Foundation Report — Expert Systems in Business, Number 60, published October 1987)

concluded that: "Expert systems are no longer laboratory curiosities. They are ripe for exploitation and Foundation members should begin to use them for live applications if they are not already doing so". We were not surprised, therefore, to find that nearly two-thirds of the organisations interviewed expressed positive interest in expert systems — albeit with a fair degree of caution and, hence, only with a medium overall interest rating. Figure 2.14 demonstrates the variety of business needs that Foundation members plan to tackle with workstation-based expert systems. A common theme is the use of expert systems to help systems professionals — not just with software development, but also with capacity planning, help-desk diagnosis, problem resolution and trend analysis, computer operations, and (ironically) with computer-aided training for workstation users.

Report 60 also identified the trend to integrate expert systems with other computer applications, although there was little evidence of this trend within the organisations we interviewed. However, the expert system requirements listed above and in Figure 2.14 imply the need to access conventional databases. The operational data that will be used by the expert systems to find patterns and associations and to give early warnings and suggest actions is stored in conventional databases.

We also discussed with user organisations the possibility of expert systems being able to remove some of the workstation ease-of-use problems discussed earlier in this chapter. We shall return to this topic in Chapter 3, but it is sufficient to say here that Foundation members are interested in a business-oriented user interface as well as one that removes the technical difficulties. For example, one organisation suggested that an expert-system-based interface could lead a departmental head gently through the intricacies of the company's budgeting philosophy, policy, and rules during the annual budget-preparation cycle. Another suggested that a business-oriented interface could enable less expensive staff to be employed instead of 'experts' who had acquired a professional mystique . . . not least in the systems profession.

**Figure 2.14 Foundation members' plans for workstation-based expert systems**

| Business sector | Requirement |
|---|---|
| Banking | Identifying arbitrage opportunities<br>Identifying infringement of regulations<br>Assisting with loan approvals, treasury analysis, and actuarial calculations |
| Public utility | Providing guidance on procedures to be followed in the event of a disaster |
| Retail | Assisting with buying decisions |
| Services | Diagnosing social problems |
| Government | Interpreting standing orders and controls |
| Manufacturing | Analysing production problems<br>Calculating optimum factory utilisation<br>Managing change during product development |

### COMPOUND DOCUMENTS

Given the lack of interest in processing computerised image and speech data, we were not surprised to find that the concept of compound documents incorporating all types of data was given a low interest rating by user organisations. The main requirement was the ability to include text, data, and graphics in the same document — preferably in colour.

However, some interest was expressed in the idea of a compound document that can be presented differently depending on users' needs — for example, as a tutorial or as a reference work. Another possibility is that documents could be presented in accordance with confidentiality classifications — with some users seeing the whole document, others only parts, with annotations displayed or suppressed; and so on.

Most of the interest expressed in compound documents was on 'a nice to have' basis — although three organisations showed specific interests. A public utility suggested that compound documents could be used to control access to confidential board minutes; a UK financial-services company suggested that compound documents could help to safeguard the privacy of a company forced to enter into a business 'partnership' as a result of the new financial-services act; a government education department suggested that compound documents could be used in conjunction with computer-aided teaching allowing the child to learn at its own pace.

None of the organisations we interviewed could see any possible application for the voice annotation of documents.

### PORTABLE WORKSTATIONS

Portable workstations received a low interest rating from our interviewees, with most of them rating them as being of low interest or no interest. Most of them do not encourage their staff to work at home, and say that their managers and professionals do not like working with lap-top computers bouncing up and down on their knees in cars (even when they are chauffeur driven), trains, or

planes. However, where staff work off-site most of the time, their employers are keen that they use portable workstations both to facilitate communications between the employee and the organisation and to ensure that the employee receives the information he or she needs to do the job well. Figure 2.15 shows some of the situations where portable workstations are considered to be important by Foundation members.

**Figure 2.15 Foundation members' requirements for portable workstations**

| Business sector | Requirement |
|---|---|
| Engineering | Engineers working at construction sites |
| | Staff working on overseas contracts |
| | Service staff on call |
| Services | Reports from field staff (social workers, for example) |
| Banking/finance | Providing advice to farmers |
| | Insurance quotations |
| | Providing financial advice in the home |
| Public utilities | Auditors working from home |
| | Meter readers |
| Retail | Shelf stocktaking |

## SUMMARY OF USERS' WORKSTATION REQUIREMENTS

We conclude this chapter by summarising the main user requirements against which we will judge the likely future workstation products.

There will be a major shift in the importance of the workstation within an organisation's overall systems architecture. By 1993, the workstation will no longer be just a personal productivity tool affecting only the working lives of the individuals that use them. Instead, the impact of the workstation will be felt at departmental or even corporate levels, and the workstation is likely to be the multifunction entry point to all of the organisation's data. This has two main implications:

- The personal workstation must be an integral part of the organisation's overall information technology plan. In Chapter 5, we discuss the impact of this implication on the systems department.
- Common interfaces, software standards embracing application-to-application communications, multitasking, and the resolution of today's interworking and communications problems are necessary prerequisites if organisations are to avoid making investments in inappropriate workstations.

These problems are all aspects of the ease-of-use concerns expressed by user organisations. The most critical questions are how far, and how quickly, suppliers will progress in solving the ease-of-use problems. We address these questions next in Chapter 3.

# Chapter 3

# Workstation hardware and software trends

In Chapter 2, we identified that, as far as workstation users are concerned, ease-of-use is still the biggest problem. We now review the main workstation hardware and software trends and assess the extent to which they will help to alleviate the concerns identified in the earlier chapter. During our research we held detailed discussions with 29 leading suppliers, researchers, and industry experts that, between them, will have a considerable impact on the future of workstation products. From these discussions, we believe that the most significant trends are:

- In five years' time, workstations will have 32 mips (or more) of processing power, 16M bytes of random-access memory, and much higher-resolution screens than today's PCs. The basic workstation will contain many more built-in functions, removing much of the need to customise workstations with add-on circuit boards. In turn, this will simplify the installation and support of workstations.
- OS/2 will eventually become the dominant workstation operating system, although by 1993 only about 50 per cent of user organisations expect to have adopted it. In the meantime, the independent software suppliers have announced their commitment to OS/2 and are preparing to write OS/2 applications.
- Considerable progress will be made in ensuring that user interfaces are consistent and are easier to use. Most suppliers (including IBM) are updating their user interfaces to provide the WIMP (windows, icons, mouse, and pull-down menus) interface that has been so successful on the Apple Macintosh. However, the WIMP interface itself will be improved, and expert systems and natural-language systems will increasingly be used to create 'intelligent' interfaces.
- Workstations will cease to be standalone. Instead they will be connected to a local area network that will provide access to shared resources and data. This will lead to the discless workstation, which could cost as little as $200 by 1993. The networking environment will lead to new types of work-group applications, allowing co-authorship of documents and multi-user spreadsheets, for example.
- Workstation applications software will comply with software standards that will ensure consistent user interfaces, allow applications to interwork, and allow programs written for one machine to run on another. As a consequence, there will be considerable changes in the workstation software-supply industry.
- IBM's systems applications architecture (SAA) will play an important role in shaping the overall computing environment, where workstations will be linked to local area networks and thence to other corporate computing resources.

## IMPROVED TECHNOLOGY WILL INCREASE THE POWER OF WORKSTATIONS

Continuing improvements in microelectronics technology will lead to workstations with more processing power and built-in memory, and with higher-resolution screens. The improved technology allows a greater number of functions to be included with the standard version of a workstation, eliminating the need for add-on circuit boards for specific functions. In turn, this will make it easier to install and support workstations (because they will no longer need to be customised).

The improved performance of workstations has implications for existing workstation applications, and it will also allow new types of applications to be developed.

### INCREASED PROCESSING POWER AND MEMORY

Over the next five years, the processing power of personal workstations will continue to increase exponentially and the size of memory will continue to increase to the stage where the norm will be at least 16M bytes. During the brief history of business microcomputers based on the MS-DOS operating system, the processing power has increased from 0.5 mips available with 16-bit (8088) processors to between 3 and 4 mips now available with 32-bit (80386) processors. The recently released Motorola

68030 chip operates at 5 mips — but when the clock cycle time is raised to 35 MHz the performance will be increased to 8 mips. Motorola's next generation of processors (the 88000 series) is now being developed and is likely to lead to workstation products available by 1990 operating at between 10 and 20 mips.

Technical workstations (such as those available from Sun and Apollo) already operate at 10 mips and the substantial price reductions of these devices during 1987 mean that they are within sight of being a real alternative to the current top range of personal computers. Even higher operating speeds (up to 40 mips) can already be achieved on personal computers by the use of special circuit boards. Such boards have two important limitations, however — they increase the cost of a personal computer by a factor of four or more, and, in general, they do not support business personal computer software.

Simple extrapolation from historical data suggests that by 1993 the typical personal workstation will have 32 mips of processing power. This may be provided by a single processor chip, and our discussions with suppliers suggest that the semiconductor manufacturers are actively pursuing this approach. However, we believe that it is more likely that processing power of this magnitude will be achieved by a combination of faster processor chips and parallel processing techniques. Such techniques could be applied:

- On a local area network, with separate specialised servers for communications, database access, and printing.
- On a personal workstation bus, with separate processors for local area network interfaces, image analysis and manipulation, screen management, and floating-point calculations.
- Within specialised parallel processors, designed to handle multiple concurrent processes, especially for artificial-intelligence and image-analysis tasks.

Examples of using parallel-processing techniques on workstations are already available. For example, there is an add-on board for Sun workstations that has 32 transputers and increases the processing power to 320 mips. A Sun workstation configured in this way currently costs more than 10 times as much as a conventional personal computer, but by 1993 the cost of such a workstation may well have reduced by a factor of 10. The existence of such boards today suggests that the prediction of 32 mips by 1993 may be too low.

Many may question whether 32 mips (or more) of processing power will ever be required in a workstation. We believe that there is no doubt that processing power of this magnitude will be required — not so much for applications processing, but to solve the ease-of-use problems identified earlier in the report.

The amount of memory in a personal computer has also grown considerably — increasing by a factor of 64 in six years (in other words, doubling each year) from typically 16k bytes of random access memory to 1M bytes. We expect this rate of growth to continue for the foreseeable future. As a consequence, the performance of workstations should improve because more programs and data will be held in random-access memory.

#### HIGHER-RESOLUTION SCREENS WILL BE AVAILABLE

The increasing use of windowing techniques, and the growing requirements for higher-quality graphics and compound documents will mean that the resolution of display screens (and the corresponding screen size) will increase over the next five years.

In 1982, personal computers typically had a monochrome screen with a resolution of 320 x 200 pixels. Today, the typical intelligent workstation has a colour screen with a resolution of 640 x 380 pixels. The new 3Com Network Station has a maximum resolution of 720 x 348 pixels, and screens with 736 x 1,008 pixels are now available. Even higher-definition screens able to replicate the quality of printed documents (possibly requiring 10,000 scan lines or more) are also being developed, but such devices are likely to be very expensive.

#### WORKSTATIONS WILL BE EASIER TO INSTALL AND SUPPORT

Until recently, the installation of a PC was a complex operation where each of the basic hardware components (processor, screen, and keyboard) could be selected separately. It was also necessary to select additional plug-in boards that would compensate for the deficiencies of the basic PC in areas such as graphics, communications, and memory size. The complications caused by the resulting mixture of suppliers and products inevitably meant that it was expensive to support the equipment.

The Apple Macintosh was the first successful attempt to address these problems. The Macintosh was designed as a sealed box (with a built-in screen) and a high basic specification, which included communications facilities. As a result, it is reasonably simple to install a Macintosh, although someone with relevant technical knowledge has to prepare a suitable start-up disc. Furthermore, a high proportion of all Macintoshes in business offices are connected to an Appletalk network, and Apple claims to have installed more local area

networks than any other supplier. However, the sealed-box design makes it difficult (but not impossible) to enhance the performance or the capabilities of the original Macintoshes with additional circuit boards.

With the announcement of the PS2 range of personal computers, IBM has gone some way towards providing similar benefits to the majority of business microcomputer users who use MS-DOS machines. It is much easier to install a PS2 than a standard PC, but not as easy as installing a Macintosh. For example, it will still be necessary to choose from a range of communications boards.

In general, we expect an increasing number of the enhancements provided today by plug-in boards to be built in to the basic version of workstations. Thus, the need to configure a workstation to meet a specific need will diminish, which means that it will be very much easier to install and support workstations. It should be no more difficult than connecting the workstation to the power supply and local area network.

#### IMPACT ON WORKSTATION APPLICATIONS

The improved performance of workstations will have an impact on existing types of workstation applications and it will allow new types of applications to be developed. For example, as with the Macintosh, it will be possible to include diagrams, charts, graphs, and so forth in text documents. And it will be possible to enhance word processing systems with glossaries, thesauri, and writing style guides.

In time, word processing systems may also be provided with voice-input facilities. There are already laboratory prototypes of speech-recognition products that can handle a substantial vocabulary. An example is the 'conversational desktop' that is intended to emulate a secretary, and combines voice recognition, a meeting scheduler, reminder file, voice messaging, and telephone answering. However, such prototypes are unlikely to lead to commercial products within five years — because it will take longer than that for speech-recognition techniques to be developed to a level where they are sufficiently accurate for workstation users. The level of accuracy that can be achieved with continuous speech recognition, even where the system has been trained to recognise a particular user, is still not sufficient for everyday use in general offices.

The increased processing power and memory of personal workstations will mean that spreadsheet applications can handle larger spreadsheets and can provide additional, and more powerful, mathematical functions. It will also be easier for the user to switch out of one application to another, and then return to the original at a later time.

New types of workstation applications and features will also be developed. Three particularly interesting areas of development will be 'intelligent' electronic mail systems, expert systems and natural-language interfaces, and hypertext. Each of these is examined in more detail in the next chapter (on pages 36 to 38).

### OS/2 WILL BE THE DOMINANT WORKSTATION OPERATING SYSTEM

Over the past 10 years, many operating systems have been written for personal computers. In the late 1970s and early 1980s, the dominant PC operating system was Digital Research's CP/M. Today, though, the three most important operating systems are Microsoft's MS-DOS (known as PC-DOS in its IBM variant), MacOS, and Unix. In the business and commercial environment, MS-DOS is the dominant operating system for the IBM PC (and compatibles). MacOS runs only on the Macintosh, and Unix is the preferred operating system for powerful engineering workstations such as those supplied by Sun and Apollo.

MS-DOS's dominance stems from the fact that it was adopted by IBM. However, MS-DOS does have serious limitations, inherent in its original 'design'. In particular, little thought was given to the user-interface aspects of MS-DOS. In effect, MS-DOS was a re-implementation of CP/M for the 16-bit Intel 8088 chip, and the degree of thought that went into its design is evident from the name given to the version that Microsoft originally bought — QDOS (quick-and-dirty DOS).

The inherent limitations of MS-DOS have become increasingly obvious to users and to application developers. They include:

- The limitation of 640k of random-access memory.
- The ability to run only one application at a time.
- The very primitive user interface to the operating system's functions (having loaded the operating system, the user is greeted with "A:").
- The inconsistent interfaces used by different applications (each developer has, in effect, designed his or her own interface).
- The difficulty of transferring data from one MS-DOS application to another.

It is these limitations, together with the opportunities provided by more powerful PCs based on chips such as the Intel 80386, that have lead IBM and Microsoft to develop the OS/2 operating system.

#### FEATURES OF OS/2

OS/2 is a multitasking operating system, designed and developed by Microsoft for personal workstations based on Intel processors. (For purists, OS/2 is actually a multiprogramming operating system, rather than multitasking; however, it is widely referred to as a multitasking system.) The initial version of OS/2 was available during December 1987. However, this version did not include the Presentation Manager feature, which will provide both the functionality of a WIMP interface and a standard for using such interfaces. Presentation Manager will be available towards the end of 1988. The user interface in the initial version of OS/2 is based on the same primitive principles as those used by MS-DOS.

There will be two versions of OS/2 — the basic version and OS/2EE (extended edition). The basic version is available to *all* suppliers from Microsoft and will be sold to users by IBM as well as by other vendors. OS/2EE, which is expected to be delivered in October 1988, will be available only from IBM. IBM is investing heavily in the design of OS/2EE and we believe the company's aim is to make OS/2EE the new intelligent personal workstation software standard. IBM has already made it clear that it will defend its OS/2EE intellectual property rights with great force.

Basic OS/2 provides many more of the traditional operating system functions than have been available with most previous PC operating systems. In particular:

- It will provide the graphics-based Presentation Manager and a common style of interface for all applications.
- It removes the 640k memory limit of MS-DOS and supports multitasking.
- Like Unix, it supports device-independent input and output.

Extended edition OS/2EE has about 30,000 lines of code not in the basic edition and is expected to provide the following main additional functions:

- The language and database support defined by IBM's SAA (systems applications architecture); the database manager will be accessed by an SQL interface. (SAA is described in more detail at the end of this chapter on pages 29 and 30.)
- A local area network interface. This product is currently being developed as a joint venture between Microsoft and 3Com. It will be available from Microsoft as LAN Manager and from IBM as LAN Server. In time, the IBM version available with OS/2EE will be different from Microsoft's LAN Manager, in particular in its support for the APPC (Advanced Program to Program Communications) protocol used by IBM.

However, Bill Gates, chairman of Microsoft, has pointed out that user organisations could build their own equivalent of OS/2EE by purchasing the basic version of OS/2 and 'bolting on' a database manager and some communications functions. The add-ons are (or will be) available from Microsoft, and the resulting extended operating system will run on existing IBM PCs (and compatibles) as well as on the PS2.

The database add-on would be SQL Server, developed by Microsoft in conjunction with Sybase and Ashton-Tate. SQL Server conforms with the relevant SAA standards. The communications functions could be provided by the Microsoft/3Com LAN Manager mentioned above.

The Presentation Manager and LAN Manager features of OS/2 are important developments because they extend the scope of PC operating systems. Presentation Manager will provide OS/2 with a Macintosh-like windows interface, together with services that can be used by application developers for managing the windows and the dialogue between the application and the user. Thus, not only will Presentation Manager improve the user interface through using the WIMP interface, it will also provide a set of tools that will make it easier to build applications that have consistent interfaces. Presentation Manager will implement many of the common user access concepts of SAA. (This aspect of SAA is described on page 24.)

LAN Manager will make it easier than at present to connect workstations to local area networks. It will also provide services that can be used by application developers to access the shared resources connected to the network.

#### THE LIKELY TAKE-UP OF OS/2

The introduction of a major new operating system for personal workstations is in its own right very significant. However, it is IBM's endorsement of OS/2 and Presentation Manager that is really significant, and many sources suggest that, as a consequence, OS/2 will eventually replace MS-DOS as the first-choice personal workstation operating system. User organisations may be more sceptical, however, because of the entrenched position of MS-DOS and the investment they now have in MS-DOS applications.

The main benefits of basic OS/2 are that it removes the 640k memory limitation of MS-DOS and permits multitasking. However, packages are available to provide multitasking in workstations that operate under MS-DOS, and the most recent announcements on Expanded Memory Specification mean that the MS-DOS 640k limitation can be overcome. 'DOS extenders' allow programs running on

80386-based personal workstations to address extra memory and to run in the 80386's 32-bit protected mode. OS/2 programs, on the other hand, are limited to the 16-bit mode and will accordingly run more slowly. (In time, though, there are bound to be 'OS/2 extenders' that allow programs to use the 32-bit mode.) Thus, at present, MS-DOS applications should be able to use multitasking facilities and use more than 640k of memory, and obtain higher performance on a 80386-based workstation than they could with OS/2. Furthermore, MS-DOS costs less than OS/2.

At first sight, therefore, user organisations have no incentive to move to OS/2. In practice, however, user organisations will make their workstation operating-system choice on the basis of the availability of applications software at a competitive price. Thus, the likelihood of OS/2 becoming the dominant workstation operating system can be assessed by examining the response of software and equipment vendors to OS/2. Figure 3.1 lists some of the major vendors that have already announced a commitment to OS/2. The list shows that most of the top PC software suppliers are now committed to OS/2. We believe that the commitment by these vendors indicates that the move to OS/2 (although not necessarily to OS/2EE) is already underway.

Nevertheless, we do not expect MS-DOS to be replaced overnight (neither, apparently, does IBM). In fact, we expect there to be an increase in the number of MS-DOS applications until at least 1990. After then, we expect MS-DOS applications to be replaced by superior OS/2 applications. From 1989 onwards, the growth in OS/2 applications will be spurred on by the emergence of non-IBM OS/2 machines.

Recent research amongst data processing managers by the MORI organisation suggested that only 8 per cent of user organisations were planning to adopt OS/2 immediately and that 50 per cent would have done so by 1992. This is in line with our own prediction. Thus, we believe that the time is now right for user organisations currently standardising on MS-DOS to begin to consider the likely impact of OS/2 on their workstation procurement policy.

The main implications for user organisations are that:

**Figure 3.1 By January 1988, the following suppliers had announced a commitment to the OS/2 operating system**

| | |
|---|---|
| Ashton-Tate | Information Builders |
| AST Research | Lotus |
| Borland International | Microsoft |
| Compaq Computer | Olivetti |
| Convergent Technologies | PC Security |
| Hewlett-Packard | Western Digital |
| IBM | 3Com |

- It will take time for software suppliers to learn how to write applications for OS/2. As a consequence, it will take two to three years (that is, until the early 1990s) until OS/2 applications begin to appear in quantity.
- OS/2 will rapidly increase the amount of memory required by the workstation because programs and data will be held in memory all the time to make the maximum use of the multitasking capability provided by OS/2. In any case, between 2M and 3M bytes of memory is likely to be required just to load OS/2 satisfactorily.

#### FUTURE DEVELOPMENTS IN WORKSTATION OPERATING SYSTEMS

OS/2 represents a considerable advance in workstation operating systems, although it is only providing many of the features that have been included for many years with the operating systems of larger computers. However, the Presentation Manager feature of OS/2 is a significant development in operating-system technology.

As operating systems have evolved over the last 20 years or so, more and more functions have been transferred to the systems software, making it easier to write applications software. In mainframe environments, this trend has resulted in separate packages such as teleprocessing monitors, database management systems, and access-control software. This trend can also be seen in MacOS and in OS/2, especially in IBM's extended edition of OS/2.

So far, however, the internal structure of applications software has not been affected by developments in operating systems. The next major advance in workstation operating systems is, we believe, likely to change the nature of applications software by providing support for the management and linkage of application components. This will allow parts of applications to be developed separately and to be used in many different applications. Applications development will therefore become more like assembling a kit of parts than writing a program, and hence it will be easier for users to develop their own applications.

Like so much workstation technology, this approach (which is implemented in 'object-oriented programming systems', known as OOPS) was pioneered at Xerox PARC (Palo Alto Research Center). The Xerox research resulted in the widely discussed, though little used, Smalltalk language. More recently, several OOPS products have become available commercially. One of the most interesting is the Object Management Facility (OMF) that forms part of Hewlett-Packard's New Wave operating environment. OMF allows data objects (representing text, images, or databases) to be combined

in compound documents and shared between applications. A compound document can be viewed as a whole, but the appropriate applications are automatically called to process (for example) an embedded spreadsheet and a pie chart, which may itself be generated from the spreadsheet.

OMF forms an integral part of Hewlett-Packard's New Wave software system, which is available now for MS-DOS PCs. However, New Wave will reach its full potential when it is combined in the future with OS/2 and Presentation Manager.

Over the next few years, we expect to see further OOPS-based developments not only in operating systems, but also in database and document-management systems.

## IMPROVEMENTS IN THE USER INTERFACE

We have already stressed the inadequacy of MS-DOS's user interface (and Unix is no better). One of the difficulties of MS-DOS is the unnatural dialogue that the user is forced to use. Another is that different styles of interface are used by different applications. For the user interface to be consistent it must be physically, syntactically, and semantically consistent. Physical consistency concerns the hardware — keyboard layout, location of keys, use of the mouse, and so on. It ensures, for example, that the function keys are always in the same place on the keyboard regardless of the system being used, or that a particular button on a mouse is always used for the same function. Syntactical consistency concerns the sequence, order, and appearance of elements displayed on a screen and the sequence of keystrokes required to initiate an action. Thus, it would be syntactically consistent to always centre the window title at the top of a window. Semantic consistency ensures that the meaning of the elements that form the interface is always consistent — for example, to ensure that the 'save' command has exactly the same meaning (and initiates exactly the same actions) on all systems.

The first commercial product designed from the outset with the user interface as a prime consideration was the Xerox Star office automation system. However, its high price and limited communications, especially with IBM systems, meant that it was not a commercial success. The Star's user interface principles were based on pioneering research work carried out in the late 1960s and early 1970s at the Stanford Research Institute and Xerox PARC. The same principles were later used on the Apple Macintosh, which became the first mass-market product with a well-designed consistent user interface.

### THE APPLE MACINTOSH INTERFACE

The two distinguishing features of the Macintosh interface are the WIMP features and the WYSIWYG (what you see is what you get) feature. The latter means that the image seen on the screen is (almost) exactly the same as that which appears on the printed version. Used in conjunction with laser writers, the WYSIWYG feature makes it easy to use a wide variety of type styles, typefaces, and graphics. A further factor contributing to the success of the Macintosh has been the User Interface Guidelines (published by Addison-Wesley). This publication provides advice and guidance on how to use the WIMP interface and has been a significant factor in ensuring that the user interface is broadly the same for all Macintosh applications.

There is now a substantial body of evidence to show that the Macintosh style of interface is much easier to use than older styles. Our own experience within Butler Cox has been that managers show much greater willingness and enthusiasm for using the Macintosh than for earlier systems. (One wit in the United States has said that Macintoshes are increasingly used by those who manage the staff that use IBM PCs.) Recent research has shown that, because the Macintosh is so much easier to use, it is used more intensively than other systems (by factors of four or more), and that the 'lost-opportunity' cost incurred whilst managers learn how to use the Macintosh is as much as 30 per cent lower. For example, one of the 'big-eight' accounting firms has standardised on the Macintosh for all of its offices worldwide to avoid the loss in fees that would be incurred if its professional staff had to undergo the lengthy training required for other, 'user-hostile', systems.

### IBM'S COMMON USER ACCESS

The Macintosh style of interface has been so successful that it has prompted many other suppliers to develop their own versions. The most significant of these is IBM. The common user access element of IBM's SAA is clearly based on the principles used in the Macintosh interface. The common user access specifications include rules for using interaction techniques such as windows, for procedures for moving from one window to another, for selecting from multiple choices, for the use of colour and emphasis, for messages, help facilities, and terminology.

Elements of SAA's common user interface will begin to appear towards the end of 1988 when the Presentation Manager feature of the OS/2 operating system is released. A major aim of the common user interface is to ensure that screen layouts are consistent. Thus, error messages will be the same for all systems, will appear in the same place on the screen, and will be highlighted in the same colour. IBM has also set itself the task of developing a common keyboard (for each country) that will be standard across all machines.

It is important to realise that the common user access element of SAA is not a product. Instead, it

is a standard that defines a consistent user interface, regardless of differences in operating environment and hardware. The aim is to make applications 'look and feel' the same, regardless of the hardware and operating system environment. Thus, users will only need to become familiar with one set of screen layouts to use IBM systems that conform to the SAA standards.

In some respects, the common user access element of SAA can be perceived as IBM's response to the success of the windowing techniques used on the Apple Macintosh. With applications written for the Macintosh, however, the individual application developer has a certain amount of freedom in deciding how the windowing technique will be used within the application. Inevitably, this leads to some inconsistencies between applications as to the way windows are used. The Presentation Manager windowing software of the OS/2 operating system will ensure that applications use windows in a consistent way.

#### FUTURE DEVELOPMENTS IN THE USER INTERFACE

During our research visits, many workstation vendors told us that the user interface had become an important development area. The original MS-DOS (and Macintosh) interfaces were designed to handle a single-process and single-user environment. Products are now available to enhance these interfaces to handle a multiprogramming (but still single-user) environment. There is, however, no consensus on the direction that further improvements to the user interface should take. There are many possibilities — the two prime ones being to refine the WIMP interface and to use artificial intelligence:

***Refinements to the WIMP interface***

Much research is being done into ways of refining the WIMP interface. In some situations, for example, it might be desirable to provide different users with different interfaces to the same application without having to alter the application. (The most obvious example is the need to cater for users' different native languages.) This facility can be provided by the Macintosh environment, but there is considerable scope for further development. For instance, it should be possible to embed the rules for house style in the user interface so they can be used automatically when preparing text and graphics documents.

A more radical development would be to support the use of icons within applications and to make the objects that they represent portable between applications. However, such a development will probably require further OOPS-based developments in operating systems, as discussed in the previous section.

Another promising idea is to extend Apple's original guidelines on how WIMP interfaces should function to include a set of ready-to-use interaction 'primitives' (buttons, menus, text areas, and so on). An 'interface editor' would be used to assemble the primitives into specific user interfaces, thus ensuring that the components of the interface are always consistent. During the next five years, we also expect to see the use of the WIMP concept standardised within applications. This is, of course, one of the aims of the common user access element of SAA.

***Use of artificial intelligence***

By the end of the 1980s, we expect to see artificial-intelligence techniques (particularly natural-language processing) being used to enhance the user interface. There are already examples of products in this area — Symantec's Q&A, for example, combines a query processor with word processing, and can cope with variations in syntax. (This product is described in more detail in Chapter 4 on page 37.) Q&A also 'remembers' what it has 'learnt' from previous interactions with a user, and therefore appears to display intelligence by not making the same mistake again. Another example is the Clout product, a database-access tool with a 800-word vocabulary. Clout was originally available with Microrim's database Rbase 4000, but when Microsoft bought the rights to Rbase it did not include Clout. The product is available in the United Kingdom from Softsel, and it now works with other database products. Clout uses the dictionary to translate a conversational query into commands the database understands. The Intellect product, which provides a natural-language interface for accessing corporate mainframe databases, is another example of a product that uses artificial-intelligence techniques to enhance the user interface.

To start with, artificial-intelligence techniques will be used to provide application-specific intelligence at the user interface. Eventually, they will be used to provide application-independent intelligence, so that the user interface of the personal workstation of the future is likely to act as an intelligent intermediary, helping users to find their way about a wide range of applications. This type of development is, of course, one of the main reasons why the amount of processing power available at the workstation will need to increase substantially.

### WORKSTATIONS WILL BE USED IN A NETWORK ENVIRONMENT

Originally, PCs were installed and used as standalone personal devices. However, PC users quickly realised that there would be advantages in being able to connect their machine to corporate mainframe systems, particularly for extracting and downloading data for local processing. The difficulty is that corporate networks were designed

to support dumb terminals and different types of applications; and PCs do not fit naturally into most existing networks. Special add-on boards have been developed to allow PCs to communicate with mainframes, and most networked PCs are now connected to host computers through products such as the Irma card.

In parallel with this development, it was realised that there were great advantages in connecting workstations to a local area network. Indeed, using local area networks in this way became the justification for the high bandwidths provided by such networks. Local area networks allow expensive equipment such as discs and printers, and communications bridges and gateways, to be shared between workstations. Shared devices must be interfaced to the network via a computer, and the combination of device and interface computer is usually called a server. Servers may be specialised single function machines (communications servers are often single-function) or multifunctional.

To date, most local area network servers have been based on MS-DOS microcomputers with special communications boards and hard discs. By definition, a server must be multitasking, and most suppliers have achieved this by implementing proprietary multitasking environments on top of MS-DOS, although a few have used multi-user operating systems like C-DOS or Xenix. In future, we believe that most local area network servers will be based on OS/2, which opens up the possibility of application developers being able to program the server. Thus, application developers will be able to decide whether it is better for functions such as database manipulation to be carried out by the workstation or by the file server.

Workstations will therefore need to be able to connect to networks for resource-sharing purposes and for accessing shared data. As a consequence, a network interface will be an integral feature of future workstations. Thus, the PC will evolve from being basically a standalone personal device where communications facilities have been added as an afterthought; instead the workstation of the future will be an integral component of the corporate information-processing network. Its role will be to provide the user with an easy means of accessing any data and applications that are available via the corporate networks — and to provide the capability for processing the applications locally.

We anticipate that telecommunications tools for use by application developers will become available. These tools will enable developers to build into applications automatic telecommunications facilities that make use of the workstation's networking and interworking capabilities — but in a way that is totally transparent to the user.

#### THE MOVE TO DISC-LESS WORKSTATIONS

Once all workstations are attached to a local area network that provides them with access to file and print servers, it is possible to simplify the workstation itself by omitting the disc drives and controller and by integrating the network interface. This type of device was available at least five years ago (from Digital Micro Systems, for example) but was probably in advance of market requirements.

In 1987, 3Com announced its disc-less personal workstation — the Network Station. This product provides the equivalent of an IBM PC/AT on a single board in a sealed box. It offers 1M bytes of random-access memory (with the option of increasing the memory to 4M bytes); it has no discs and no expansion slots for add-on boards — but plenty of ports; it is networked via Ethernet, which provides the necessary servers for data access and printing. Because of its sealed-box design, the Network Station is relatively inexpensive — costing 60 per cent less than the equivalent IBM intelligent personal workstation (PC) when it was announced in April 1987.

By the beginning of 1993, we expect that there will have been a significant move towards disc-less personal workstations, with data-access and printing facilities being provided by servers on the local area networks to which workstations are attached. There are several factors that will promote this move. By 1993, the price of a disc-less workstation could be as low as $200, significantly less than a conventional workstation. The performance of disc-less workstations should also be better than that of conventional workstations because they are likely to be optimised for loading programs and transferring files from the local area network. Also, the local area network servers they will use will have large high-speed cache memories and hard discs that provide faster data access and transfer rates than the disc drives built into conventional workstations. The overall benefits of disc-less workstations are, therefore, lower cost, higher performance, no noise and little heat dissipation (because there are no moving parts), and ready access to network resources (such as data storage, printing services, links to other workstations, and so forth).

A further advantage of disc-less workstations is that it is much easier to ensure that proper data-integrity and data-security practices are carried out. Workstation users are becoming increasingly concerned about the management of data and software, and the disc-less workstation removes the need for users to have to worry about such issues. In some organisations, therefore, disc-less workstations (in conjunction with a common

network and a shared data dictionary) may be used to extend the influence of the systems department. In other organisations, however, disc-less workstations will be seen simply as a means of providing users with more effective computing resources at a lower price, and users will not lose any control over their applications and personal files of data.

#### IMPACT ON APPLICATIONS

In order for a workstation application to interwork with applications on another computer (a mainframe, for example) it is not only necessary for data to be transmitted across a network, it is also necessary to establish a logical connection between the applications. For example, a spreadsheet application running on a personal workstation needs to be able to 'understand' and process data that is downloaded from a mainframe.

It is therefore necessary for the applications to conduct an orderly dialogue and for the data transferred to comply with formatting rules known to both applications. The former requires protocols (such as the SNA 'conversation-type' protocols), and the latter requires rules both for documents and for structured data. For example, documents might conform to the X.400, DCA (document content architecture), or ODA (office document architecture) standards. The emerging *de facto* standard for structured data is SQL.

IBM's SAA standards are also designed to address the application-to-application communications. In particular, the common communications support element of SAA is concerned with the connectivity of systems and programs. It will be used to connect applications, networks, and devices by ensuring that specific communications architectures are implemented in a consistent manner in each of the SAA environments.

The increased networking capabilities of workstations will mean that members of a working group will be able to communicate with others through their workstations and will be able to access the same data and applications. Indeed, some suppliers are promoting the idea that substantial productivity gains from using personal workstations can be obtained only by exploiting the group-interworking opportunities provided by linked workstations. Although we reported in Chapter 2 that few organisations have formally recognised the need for group interworking, many do now have a large number of small applications that support particular working groups. Other organisations are beginning to consider seriously the benefits that group-interworking could bring. For example, the World Bank reported that a survey conducted in 1987 showed that its staff do work in groups and that the typical size of a group is 20 people. The most important finding in the context of this report was that 80 per cent of all communications to the members of a group were from other members of the group.

At present, many existing work-group systems run on mainframes and are supported by the organisation's information centre. In future, the increased functionality of workstations will mean that these applications will be transferred to the workstation.

In addition, the combination of personal workstation networking with the interworking possibilities provided by architectures like SAA, together with the increased processing power and memory that will be available with workstations, will make it possible to implement totally new types of applications. Possible applications include:

- Work-group collaboration systems that permit co-authorship of documents and provide shared filing facilities. Such systems could also provide multi-user spreadsheets where each user works on a subset of the spreadsheet. All subsets would have a common format definition, however, and the system would allow them to be consolidated into a master spreadsheet.
- Systems that permit collaboration between members of a work group, but without the need for them to be physically at the same location. Computer conferencing systems such as VM Notes (offered by DEC for use in VMS environments) provide such facilities, and we anticipate that desk-to-desk teleconferencing systems will be available. Another approach is to enhance electronic mail systems so they 'understand' the meaning of a message and can record whether the sender is asking a question or issuing an order. Systems such as Action Technologies' Co-Ordinator track the development of dialogues in which people make commitments to each other and generate reminders at an appropriate time.

### WORKSTATION APPLICATIONS WILL NEED TO COMPLY WITH SOFTWARE STANDARDS

In most computing environments there are certain features of the operating system that are specific to the particular hardware and software. Applications that make use of these features will almost certainly need to be changed before they can operate on different hardware or under different operating systems. Thus, if applications are to be written so they can be transferred easily from one workstation to another, it will be necessary to avoid using some of the available features.

Furthermore, applications will be easier to use if they always interact with users in a consistent

standard way. Many user organisations have attempted to address this difficulty by specifying their own standards for screen formats and function keys. However, they still have to use software from external suppliers that uses different standards.

More recently, Apple attempted to address this difficulty for the Macintosh by encouraging application developers to use the User Interface Guidelines publication, which contains detailed instructions about how to use the WIMP interface. It also warns that Apple will only recognise applications that comply with the guidelines.

#### THE SAA COMMON PROGRAMMING INTERFACE

IBM is also trying to define programming standards for applications software, again through the SAA standards. The common programming interface element of SAA covers the languages, commands, and calls used by application developers to develop applications software. The purpose of the common programming interface element of SAA is two-fold. First, applications that conform to the specifications should be able to run in the different IBM computing environments that provide support for SAA. (In time, if other suppliers adopt the same interface standards, it will be possible to run applications on their hardware as well.) Second, it means that it will be very much easier to pass data between programs written in different languages and running in different computing environments. Thus, a Cobol program running on a mainframe, and conforming with the SAA specifications would be able to download data to an SAA application running on a workstation in such a way that the receiving program will be able to immediately understand and process the data.

In some respects, therefore, the common programming interface element of SAA is a response by IBM to the success of DEC's single VMS operating environment across its full Vax product range.

#### THE POSIX INITIATIVE

There is still much activity to promote Unix as the means of ensuring compatibility and portability between different ranges of equipment. For example, the IEEE is working on standards for the programmers' interface to Unix — the portable operating systems interface (Posix). The final version of the Posix standard is expected to go to an IEEE ballot in the first quarter of 1989. Similar work is progressing in the International Standards Organisation (ISO), where it is likely that a draft Posix standard will be produced in 1988.

The Posix initiative results from the need of all computer suppliers (with the exception of IBM and DEC) to define a common environment for software developers. Many government agencies are beginning to insist on Posix standards (the United States Air Force, for example, is ordering equipment worth several billion dollars that conforms with Posix) and, for this reason, it will be of increasing importance.

In summary, workstation applications will have to conform with software standards. The standards will ensure that the user interface is consistent, that applications can interwork with each other, and that applications written for one machine can be run on another. These developments are of profound significance for user organisations. They will also lead to major changes in the workstation software-supply industry.

#### CHANGES IN THE WORKSTATION SOFTWARE-SUPPLY INDUSTRY

At present, the supply of general-purpose personal workstation software is dominated by a handful of extremely successful suppliers — notably Microsoft, Lotus, Computer Associates, Ashton-Tate, and Borland. Interestingly, all of these suppliers came into existence to supply software products for the rapidly growing population of PCs. None of them were software suppliers in the more traditional minicomputer and mainframe markets, although several are now diversifying into these areas. To begin with, all of the successful PC-software suppliers were small innovative companies. However, their rapid growth means that they are now less prepared to take risks and, as a consequence, they are now less able to innovate.

Innovative products will, of course, continue to appear, but increasingly they will be from smaller companies. The main difference in the workstation-software supply industry over the next five years is that small companies are unlikely to be able to grow at the rate and to the size that today's market leaders did. When companies like Microsoft began to operate, there was a brand new market and no established market leaders. The situation is now different because the major established PC-software suppliers are large enough to frustrate the plans of small entrepreneurial companies. For example, Lotus probably spent more on promoting its 1-2-3 product than on developing it in the first place. Today, the highly competitive marketplace, with success dependent on market share, means that it would cost even more to market and advertise a new product. Unfortunately, small start-up companies do not have the financial resources to enable them to promote new products in the way that the established suppliers can.

It is, of course, possible that one of the established PC-software suppliers will go out of business — especially since several of them are still basically

one-product companies. However, most of them have been strengthening their product base by arranging to supply a range of related applications. The range typically includes a spreadsheet, a word processing package, a graphics package, and a database management system. Examples include:

- Ashton-Tate, supplier of the dBase range of products, has purchased Multimate and its word processing product.
- Lotus's announcement of its intention to provide a database management system.
- Microsoft now provides the best-selling spreadsheet for the Apple Macintosh.

Doubtless other applications will be added to the range of products offered by PC-software suppliers — just as the product ranges of mainframe-software suppliers were extended some years ago.

At the same time, established mainframe-software suppliers such as MSA and Cullinet will be able to compete directly with PC-software suppliers like Lotus, Microsoft, and Ashton-Tate. This will come about because applications conforming with appropriate software standards will be portable from mainframes to workstations and vice versa. In the long term, therefore, architectures like SAA are likely to radically change the software-supply industry.

## THE SIGNIFICANCE OF IBM'S SYSTEMS APPLICATION ARCHITECTURE (SAA)

We have already mentioned IBM's SAA several times in this chapter. The fact that we have done so is an indication of the broad scope of SAA, which has elements covering the user interface, programming standards, and communications. There is, in fact, a fourth element to SAA — common applications. This element covers applications software (from IBM and other software vendors) built in accordance with the SAA standards. Initially, IBM's application-development effort will focus on integrated office and decision-support systems. Later, the applications effort will be expanded to include industry-specific applications.

The rationale for SAA can be viewed in several ways. At one level it can be seen as an attempt by IBM to pull together its disparate product lines, architectures, and protocols into a single architectural framework. Alternatively, the common user access element of SAA can be seen as IBM's response to the success of the Macintosh WIMP interface. Or the common programming interface and common communications elements can be seen as IBM's response to the success of DEC's Vax range of hardware, which has sold very successfully over the past few years mainly because of the attractions of the single operating-system environment (VMS).

In many respects, however, the rationale for SAA rests on the premise that intelligent-workstations will form the user interface to applications that run on larger systems. However, it is clear from the list of products excluded from SAA support (CICS, IMS, TSO, and so on) that the initial thrust of SAA will be at end-user computing, decision-support, and management-information applications, not at mainstream transaction-processing applications. This means that SAA is of fundamental importance to the future of linked intelligent workstations (that is, the PS2) in the IBM environment.

Further evidence for the initial importance of the PS2 in establishing SAA is IBM's statement that "The common user access is still evolving. It is being created for intelligent workstations and will grow through the midrange systems to the mainframe systems." This implies that the key to portable applications under SAA will be systems that have an intelligent workstation (the PS2) as the sole user interface.

Yet another way of perceiving SAA is to see it as an attempt by IBM to set the standards that will shape the IT industry for the rest of this century and beyond. Whichever way SAA is viewed, it is undoubtedly an important development, not least because it is an IBM initiative. As such, other suppliers cannot afford to ignore it.

At the present time, however, SAA is little more than a concept and it will be several years before the majority of IBM's product range conforms to the SAA standards. Indeed, the standards are still being defined, and the scope of SAA will inevitably be extended as it evolves. For these reasons, it will take until the mid-1990s before there is a wide variety of SAA applications software available from independent software vendors.

So why is it that, with all of the uncertainties about the nature of SAA and the timescale over which it will be introduced, we believe that SAA is such an important development? Although it is too early to be certain, we believe that SAA will play an important role in the development of corporate computing over the next few years. The evidence to support this view is partly by analogy with the introduction of SNA and partly circumstantial.

There are strong parallels between the launch of SAA and the launch of SNA. When SNA was first launched in 1974, it was little more than a concept and was dismissed by much of the rest of the industry as nothing more than an attempt by IBM to put its house in order. Today, SNA is the *de facto* standard for commercial data networking, and other suppliers have to take account of SNA in their

product plans. We would not be at all surprised to find that, in 10 years' time, the SAA standards have the same kind of dominance, with other suppliers having to at least provide 'bridges' to SAA environments. Indeed, IBM has made it clear that the SAA interface specifications will be non-proprietary and that other suppliers will be encouraged to provide equipment and software that conform with the architecture. Thus, although SAA will initially be implemented on IBM products, we believe that eventually other suppliers will also provide equipment and software that conform with the SAA standards.

The circumstantial evidence comes from the interest that third-party software suppliers are already taking in SAA. Micro Focus, for example, has changed some aspects of its Cobol compiler to take account of the SAA common programming interface standards. And CINCOM has announced that the SAA common user access interface standards will form the basis of the window interfaces for SUPRA, a relational database product. SAA is in fact, a good example of the type of architecture that will be required if the ease-of-use problems identified in Chapter 2 are finally to be solved. Undoubtedly, there will be other initiatives from other suppliers — Olivetti has already launched its Open Systems Architecture (OSA), for example, and the recent alliances between DEC and Apple and between AT&T and Sun illustrate that major suppliers recognise the importance of intelligent workstations being able to link effectively with mainstream data processing systems.

All of the initiatives are moves in the right direction but, in order to satisfy all user requirements, suppliers would need to abandon many of the practices of the past. In particular, it would require all of them to comply with a common set of standards for communications, for software, and for the user interface. In reality, this is unlikely to happen within the future timescale we are considering in this report. However, during the next five years, IBM will be striving to establish SAA as the *de facto* standard in these areas. Other suppliers are likely to respond by collaborating with each other and attempting to establish their own *de facto* standards. The implication for user organisations is that they will continue to need to choose a standard and then select products that comply with that standard.

# Chapter 4

# The personal workstation of the future

So far in this report we have established that user organisations want workstations that are easier to use, and that workstation suppliers are addressing the ease-of-use difficulties. We have also established that, by 1993, the workstation products available should have largely solved the problems that, today, are of most concern to user organisations. In this chapter, we now combine the users' requirements with the likely technology and software developments and predict the characteristics of the personal workstation of the future.

In summary, by the beginning of 1993 we foresee:

- The emergence of a two-tier computing environment, consisting just of mainframes and interlinked intelligent workstations, which will be connected to a local area network and thence to file servers, print servers, and communication servers. Often, workstations will perform the functions carried out by today's departmental minicomputers. Most of an organisation's computer processing will be performed by such workstations, except for mainstream batch and transaction-processing applications and database maintenance functions, which will continue to require mainframe systems with dumb terminals. Furthermore, workstations and mainframes will be interlinked in a way that permits processor-to-processor communications.
- The availability of workstations with 32 mips (or more) of processing power and 16M bytes of random-access memory. Printing, data-access, and communications functions will be carried out via shared servers which means that most workstations will be disc-less.
- OS/2 will become the *de facto* operating system standard for business workstations, allowing the workstation to become an integral element of corporate information-processing systems.
- A reduction in the total costs of workstations by about one-third (in real terms). However, a much higher proportion of the costs will be absorbed by support and service costs.
- The increasing availability of advanced facilities like structured electronic mail, expert systems, and hypertext. These facilities are likely to stimulate even higher growth in the use of workstations and in the number of workstations installed than Foundation members were predicting in the survey carried out for this report.

## WORKSTATIONS WILL REPLACE DEPARTMENTAL MINICOMPUTERS

In the past, user organisations have tended to select specific computing products to meet specific needs — the result being that they now have a diverse range of discrete (and incompatible) systems and applications. This approach has been encouraged by the vendors, with the market leaders concentrating on specific areas of the market and carefully developing and protecting their own specialised market niche. Thus, the CAD/CAM market has been dominated by Sun and Apollo, the minicomputer market by DEC, and the mainframe market by IBM.

The price/performance ratio (measured in terms of dollars per mips) of equipment has varied enormously between these different markets. However, this has been of little consequence whilst user organisations' total computing budgets continued to grow quickly, and, more importantly, whilst it was impossible for products designed for use in one area to be used in a different area. These factors have lead to the three-tier computing environment (mainframes, minicomputers, and workstations) now found in many organisations.

Over the past few years, however, the situation has changed considerably. The price/performance differences between different market niches has narrowed — for example, the price of the least expensive specialised engineering workstations is now very similar to the price of top-of-the-range personal computers. Furthermore, the growth in computing budgets is slowing down. And finally, there are now clear indications that equipment designed originally for one purpose is being used increasingly for other purposes. The trend (identified in Chapter 2) to linked intelligent workstations and multifunction operation is

evidence of the changes taking place. The result is that suppliers will increasingly be competing in most, if not all, of the market niches, not just in their chosen speciality. Some recent activities by suppliers illustrate this point:

- DEC has developed an engineering technical workstation that operates under a version of Unix rather than under its own operating system, VMS. Unix has become the *de facto* standard for technical workstations, with more than half of all technical workstations running under it. DEC is so concerned about this market niche that it is prepared to compromise its hitherto successful policy of having only one operating system across its full Vax product range.
- Apollo and Sun have reduced substantially the prices of their technical workstations and are aggressively marketing them to personal computer users in financial-services companies. Both Apollo and Sun claim that the advanced facilities (such as expert systems and financial modelling) required to support financial advisors are more akin to the facilities provided by their technical workstations than those provided by conventional personal computers.
- On the other hand, Compaq claims that an increasing number of engineers are using its personal computers — with its 30386-based machines providing performance comparable to technical workstations.
- In order to counter the threat to their business from personal computers, dumb-terminal vendors are prepared to offer price discounts and are launching new products that provide some local processing functions.
- Hewlett-Packard is now providing its own line of IBM-compatible (3270) dumb terminals.
- AT&T and Sun Microsystems have joined forces in a bid to provide a full range of computers and workstations and, hence, to compete with IBM and DEC.
- DEC and Apple have agreed to collaborate — the aim being to provide DEC with a viable powerful desktop computer, and Apple with an entry into all DEC users, and to place both companies in a better position to compete with IBM and OS/2.

To summarise, we believe there are three separate trends:

- The removal of one of the three computing levels — the minicomputer — leaving just mainframes and interlinked workstations. The 1987/88 Datamation/Cowen & Co institutional services mini/microcomputer survey supports this view. The results of this survey showed that linked personal workstations are already beginning to replace minicomputers as the preferred small systems for distributed processing. Nearly two-thirds of the survey sample had chosen linked intelligent workstations both for their new office applications and for their mainstream applications. Perhaps even more interesting was the survey finding that suggested the preference for linked workstations is increasing the demand for mainframe-based services because of the interworking and communications needs.
- The elimination of the distinction between specialised workstations and linked personal computers. Given the processing power and memory of, say, an IBM AT with an enhanced graphics adaptor (EGA) display and a local area network interface, it only requires an upgrade in the operating system and the establishment of a peer-to-peer communications protocol for the personal computer to become indistinguishable from the specialised workstation. In the previous chapter, we provided evidence to show that this is precisely what will happen over the next five years.
- A reduction in the use made of dumb terminals. However, in the data-entry departments of organisations like banks and insurance companies, the dumb terminal will continue to be the most cost-effective data-input device.

## THE PERSONAL WORKSTATION WILL BE AN INTEGRAL PART OF CORPORATE SYSTEMS

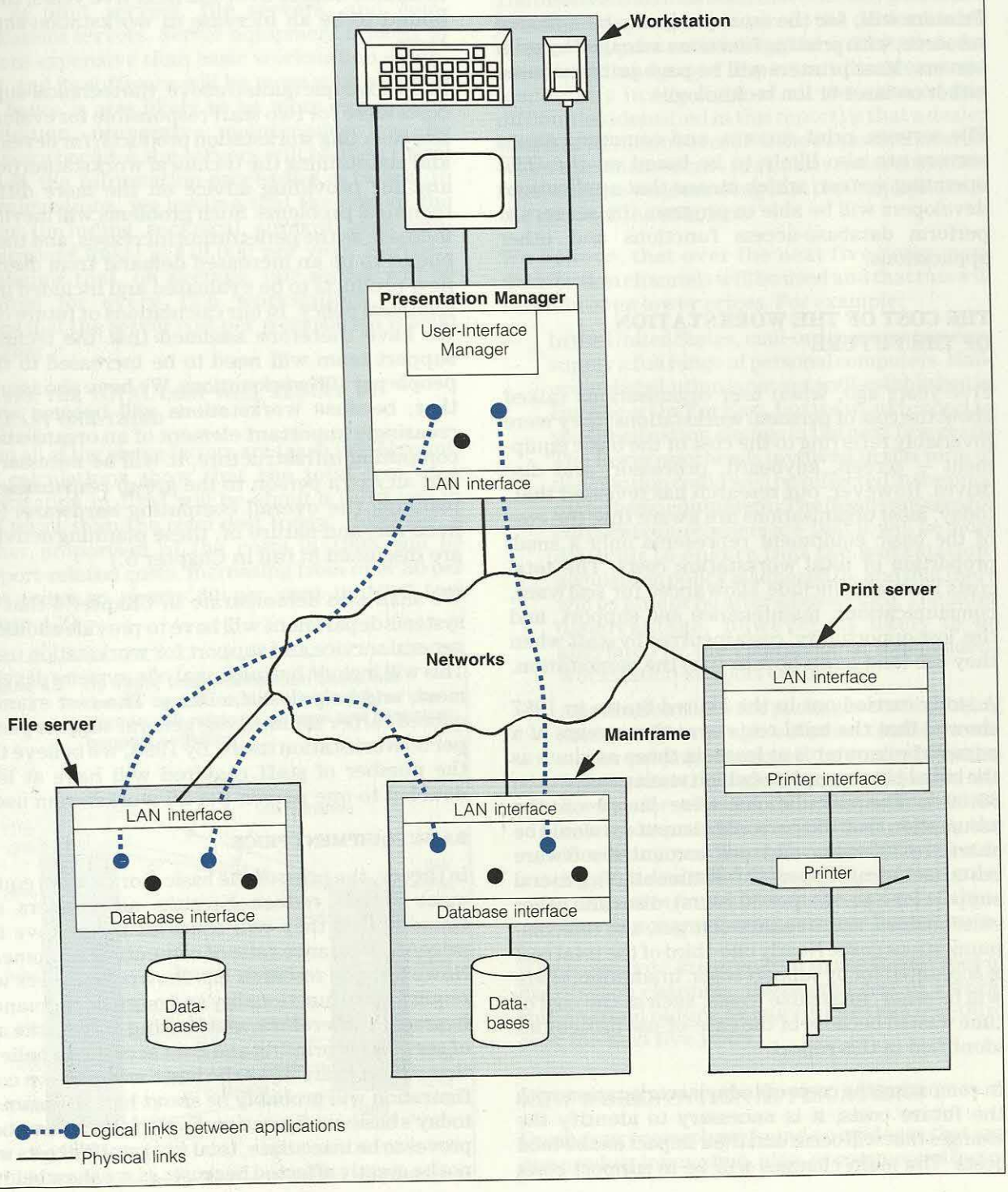
Figure 4.1 shows how the personal workstation will become an integral element of an organisation's overall computing architecture. The architecture is distributed, with much of the applications processing power being located in the workstation. Workstations will be interlinked via local area networks (which may themselves be interconnected by wide-area networks). The networks will provide access to shared resources such as data, printers, and gateways to other systems and networks. Because all of the elements will conform to a common architecture (such as SAA), applications running at the workstation need not be concerned with the physical location of data. A request for data by a workstation application may result in data being retrieved from a file server attached to the same local area network or from a remote mainframe, or from both.

The workstation itself will consist of a keyboard, mouse, and screen, all controlled by the operating system's presentation manager. There will be no disc controller or disc drives in the workstation — but there will be an integrated local area network interface. At the low end of the range, the workstation will have between 2 and 4 mips of processing

power, a screen with at least 1 million pixels, 3M to 6M bytes of memory, and a multitasking operating system with windowing facilities (most probably OS/2). At the high end of the range, workstations will have up to 32 mips of processing power and 16M bytes of random-access memory.

A user interface interpreter will separate the applications from the presentation manager. This interpreter will most likely be an expert system that acts as an intelligent advisor, leading the user through the application from both a technical and a business point of view. This concept has already

**Figure 4.1 Future systems architecture**



been implemented in Hewlett-Packard's New Wave product, and we believe IBM's new office systems software being developed in accordance with the SAA standards will contain similar features.

Data will be accessed via file servers. All data will therefore be stored remote from the workstation, on hard discs (or optical discs) either as a shared data resource on the local area network, or on mainstream systems that are accessed via file server 'gateways'.

Printers will, for the most part, also be a shared resource, with printing functions managed by print servers. Most printers will be page printers based either on laser or ion technologies.

File servers, print servers, and communications servers are also likely to be based on the OS/2 operating system, which means that applications developers will be able to program the servers to perform database-access functions and other applications.

## THE COST OF THE WORKSTATION OF THE FUTURE

Five years ago, when user organisations talked about the cost of personal workstations, they were invariably referring to the cost of the basic equipment — screen, keyboard, processor, and disc drives. However, our research has revealed that, today, most organisations are aware that the cost of the basic equipment represents only a small proportion of total workstation costs. The total costs must also include allowances for software, communications, maintenance and support, and the 'lost-opportunity' costs incurred by staff when they use (and learn how to use) the workstation.

A study carried out in the United States in 1987 showed that the total costs over three years of a personal computer is at least six times as much as the initial purchase price (which was assumed to be $5,000). The calculations were based on the assumption that 100 personal computers would be shared by 300 users, and took account of software costs, technical support (2 full-time staff), general support (one person per 50 users), discs and other consumables, maintenance charges, and telecommunications costs. Nearly one-third of the total cost is accounted for by support costs. In addition, there will be other 'intangible' costs, such as the cost of time wasted because of the ease-of-use difficulties identified in this report.

In comparing the costs of today's workstation with the future costs, it is necessary to identify the changes that will occur and their impact on the total costs. The main changes will be in support costs (which will increase as the penetration of workstations increases), in the price of the basic equipment, in software and other direct costs for consumables and maintenance, and in the costs of shared network resources.

### SUPPORT COSTS

At present, support costs form a larger proportion of the total costs than the combined costs of hardware and software. As we expect the penetration of workstations amongst white-collar staff to almost double over the next five years, there is bound to be an increase in workstation-support costs.

In the example quoted above, the technical-support costs were for two staff responsible for evaluating and selecting workstation products, for developing and maintaining the technical workstation policy, and for providing advice on the more difficult technical problems. Such problems will inevitably increase as the penetration increases, and there is bound to be an increased demand from users for new products to be evaluated and included in the technical policy. In our calculations of future costs, we have therefore assumed that the technical-support team will need to be increased to three people per 100 workstations. We have also assumed that, because workstations will become an increasingly important element of an organisation's computing infrastructure, it will be necessary to add an extra person to the group responsible for planning the overall computing hardware. (The need for, and nature of, these planning activities are discussed in full in Chapter 5.)

We shall also demonstrate in Chapter 5 that the systems department will have to provide additional general service and support for workstation users. This will include business analysis, systems development, and help-desk facilities. The cost example quoted earlier assumed one general-support person per 50 workstation users. By 1993, we believe that the number of staff required will have at least doubled to one person per 25 workstation users.

### BASIC EQUIPMENT PRICE

In theory, the price of the basic workstation equipment should reduce because all vendors are claiming that they will continue to improve the price/performance ratio of computing equipment. However, our research has shown that users will require more functionality and more performance. In practice, therefore, and bearing in mind the use of servers for printing and data access, we believe that in five years' time the basic workstation configuration will probably be about half the price of today's basic configuration. Even if this assumption proves to be inaccurate, total workstation costs will not be greatly affected because, as we show below,

equipment costs will form a small proportion of the total costs.

Maintenance costs (which were assumed to be $300 per workstation per year in the earlier example) should also reduce because the overall trend does seem to be for workstation equipment to be more reliable.

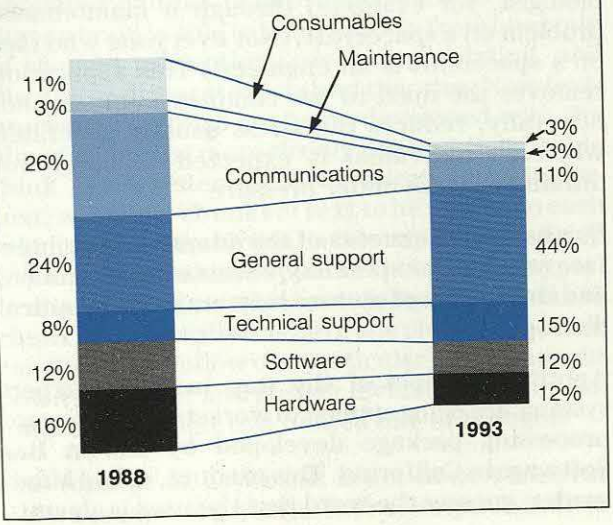
#### SHARED NETWORK-RESOURCE COSTS

The final cost element to take account of is a provision per workstation for shared resources such as print servers, file servers, and communications servers. Server equipment is likely to be more expensive than basic workstation equipment, and its software will be more sophisticated (and hence is also likely to be more expensive). In addition, preventive maintenance may be necessary because the servers will be the critical links in the information-processing network. In our calculations, we assume that the cost of the server (including technical support and communications links) is $10,000 per year. Further, we assume that, on average, one server will be required for every 12.5 workstations, which means that the server cost per workstation is $800 per year.

#### BY 1993, THE TOTAL COST WILL REDUCE BY AT LEAST ONE-THIRD

When all of the above factors are taken into account, our calculations show that the total cost of a workstation in 1993 will be about a third less in real terms than the total cost today. However, a higher proportion of the costs in 1993 will be support-related costs, increasing from over 30 per cent today to nearly 60 per cent in 1993 (see Figure 4.2).

**Figure 4.2 By 1993, total workstation costs will reduce by a third, but a much higher proportion will relate to general and technical support activities**




There is, however, another very significant factor that could have a considerable impact on the price of the basic workstation equipment. That factor concerns the distribution channels through which user organisations acquire workstations. Over the past few years, the lower end of the personal computer market has been supplied by independent dealers and retail outlets prepared to accept much smaller margins than more traditional distribution channels. These dealers and outlets have adopted pricing policies similar to those used in consumer retailing, and users have benefited significantly. The disadvantage has been that once any guarantee (usually one year) has expired, the dealer has no responsibility for maintaining the workstation. An associated and more important disadvantage (especially in the light of all the ease-of-use difficulties identified in this report) is that a dealer has no motivation to resolve the disputes that arise when a problem occurs in a multivendor situation, where all the vendors deny that their equipment is the cause of the problem.

We believe, that over the next five years, new distribution channels will be used and that this will result in even lower prices. For example:

- In the United States, mail-order companies now supply a full range of personal computers. Mail-order distribution is not yet well-established in Europe or the Far East, but we would expect to see the situation change in the next few years. The lower overheads involved in this form of distribution could well be reflected in the price of the basic equipment. The disadvantages for corporate purchasers are that it will be more difficult to ensure that the workstation-acquisition policy is adhered to, and that there will be little or no after-sales service. The latter disadvantage, however, is likely to be alleviated by the emergence of independent workstation-support companies.
- Application software packages are now being sold in high enough volumes to allow consumer-pricing practices to be applied. We also believe that the high volumes will lead to site licences for software, rather than a licence that relates to a single workstation. Again, the increasing trend for software to be distributed through dealers, retail outlets, and mail order companies could hasten the arrival of these new commercial arrangements for software.

If organisations are prepared to use these types of distribution channels, the overall cost of a workstation could reduce by much more than one-third over the next five years.

### NEW WORKSTATION APPLICATIONS

During our research we found no evidence that any one product innovation, idea, or commercial factor

will fundamentally change the way in which people use workstations to help with their work. Nevertheless, we believe that the combined effect of several innovations, concepts, and initiatives could result in considerable changes over the next five years. An underlying theme of the changes is the use of processing power to make the actual operation of the workstation and the routines that run on it closer to the way in which people naturally work. Hitherto, people have been expected to change their working practices to fit in with the limitations and constraints applied by the workstation. What is now happening, in effect, is that additional processing power is being used to change the working practices of the workstation. As this happens, we believe there could well be an unprecedented increase in the use of workstations — much greater than that predicted by the user organisations in our surveys. Good examples of the developments that are occurring can be seen in the so-called structured electronic mail products, in various initiatives with artificial intelligence — either to allow the user to interact with the workstation in natural language or to use expert systems that help to make the best use of the workstation — and in hypertext applications. Each of these developments is now examined in more detail.

#### STRUCTURED ELECTRONIC MAIL

In Chapter 2, we predicted that a growing proportion of personal workstations will be used for electronic mail. We believe that the use of electronic mail will be stimulated by some new and very sophisticated facilities made possible by combining electronic mail with other techniques — such as expert systems, advanced office functions, and so on. The following examples are particularly interesting:

- The ability to filter messages and to reject automatically those that the recipient would not want to read. Hewlett-Packard and DEC already have their own in-house facilities that allow staff to define (individually) what constitutes 'junk mail'. Electronic mail messages meeting the junk-mail criteria are deleted automatically from the individual's mail box. Commercial prototypes of such systems have been developed by other suppliers.
- The ability of the messaging system to analyse the message semantics and thus recognise whether the message informs, makes suggestions, asks questions, offers and requests information, and so on. The importance of such a facility is that different message types can be treated differently. For example, when the system recognises a message that requests information it looks for the date by which the answer is needed. If the message sender is still waiting for a reply on the due date, the system reminds him or her of that fact. In the first product of this type — Action Technologies' Co-Ordinator — the message sender must describe the meaning of the message to the system. In the future, natural-language processing systems will analyse the incoming message. This technique is being pioneered at the Massachusetts Institute of Technology in the Information Lens system.
- The use of fixed-layout electronic mail messages that can be used to capture and validate data which is then passed through to a data processing system. Thus, electronic mail could become a tool for certain types of systems development activities.

All of these examples are included in the generic term 'structured mail'. We believe that structured mail will be an important growth area in the next five years.

#### EXPERT SYSTEMS AND NATURAL-LANGUAGE INTERFACES

In Foundation Report 60 (Expert Systems in Business) we said that the growing business use of expert systems will, in part, be due to the many inexpensive and effective expert systems tools that are now available for use on intelligent personal workstations. The research for this report validated that claim, and provided examples of some interesting recent developments.

For example, an 'adaptive user interface' has been developed in the United Kingdom by Logica. This system learns about an individual as he or she is trying to understand how to use a computer system, and constructs a profile of the individual's ability and limitations. Using this profile, the user interface can lead the individual through the application system in a way that is likely to be the most helpful to the individual concerned. One particular application of this interface guides a non-engineer (a biologist, for example) through a maintenance problem on a spacecraft. (Not everyone who flies on a spacecraft is an engineer.) This application removes the need to use complex manuals and, hopefully, reduces the stress usually generated when an individual is expected to carry out unfamiliar tasks under pressure.

Further developments of the adaptive user interface may involve speech synthesis and recognition, and the display of picture references from optical discs.

Another example of the way in which expert systems are being applied to workstations is a word processing package developed by Brown Bag Software in California. This product, called Mindreader, guesses the word that the user is about to

type and displays its guess in an 'option' box. If the user agrees with the guess, it can be transferred to the right place in the document with a single keystroke. The software is able to analyse and reproduce the way an individual uses words, so the more an individual uses Mindreader the more likely the system is to guess correctly. Mindreader, of course, is not aimed at professional copy typists, most of whom do not look at the screen as they type.

An example of an intelligent natural-language interface is Q&A (from Symantec Inc. in California). One feature of Q&A is the Intelligent Assistant, which allows users to interact with databases through questions and commands in ordinary English. Furthermore, the system recognises that there are many different ways of asking the same question. Figure 4.3 shows a partial list of the variations for a request for information that can be understood and acted on by the Intelligent Assistant. The objective is not to constrain the user to a restricted subset of English — interfaces based on a restricted language subset in effect require the user to learn another formal language. Thus, the Q&A system has the ability to recognise many alternative expressions of the same basic idea. This means that it takes much less time to learn how to use the system than it does for more conventional user interfaces.

We believe that increasing use of expert systems and natural language will be made as a means of improving the user interface to personal workstations — both to help the user make the most of the technical facilities available, and to guide him or her through unfamiliar applications.

**Figure 4.3 Partial list of query variations that can be understood by the Q & A Intelligent Assistant**

Female salaries
Show the female salaries
Salaries for females
Salaries of the women
What do we pay the women?
What are the salaries of the female employees?
What are the women paid?
Please find the earnings of our women employees and present them for me
How much pay do women get?
Get the salaries of the employees who are women
Get the salary data on all females
What salaries do the female employees have?
I want to see the salaries of the female employees
Can I have the salaries from the records for females?
Please make a report that shows the values from the salary field from all forms where the value in the sex field is female
For female employees, make a list of the salaries
If an employee is female, I want to see her salary

#### HYPERTEXT

Most computer systems process text and information linearly — one character after another. However, this does not match the way that people process information. Most people think in a non-linear way, making associations between apparently unrelated 'chunks' of information. In this way, the human brain is able to jump quickly from one train of thought to another, reviewing, relating, and discarding disparate facts and theories. New text-processing systems are being developed with the aim of mirroring more closely the way that people think. These systems, known collectively as hypertext, will allow chunks of text to be related to each other so that the user can decide which relationship to pursue and when to pursue them. Thus, hypertext systems allow the user to jump from chunk to chunk of information as he or she pleases. The user can therefore follow one particular line of thought down to greater and greater levels of detail or can jump at any point to a related line of thought.

The concept of hypertext is not new. Vannevar Bush was credited with its first description in 1945 in his article 'As we may think', published in Atlantic Monthly. Its implementation is relatively new, however, mainly because of the huge amounts of processing power and memory that are required. An early well-known implementation of hypertext is the Notecards system developed at Xerox PARC (Palo Alto Research Center). Notecards is aimed at researchers using a Xerox D-series Lisp machine.

A more recent example of a hypertext-like product is Hypercard, Apple's hypertext product for the Macintosh, which is described by Apple as a tool for organising personal knowledge. Hypercard certainly can be used to do this, provided the knowledge fits into the chunks and relationships defined by the software. However, the procedures for creating new chunks and relationships are complex. Another drawback of Hypercard is its inability to transfer personal knowledge from other software systems — MacWrite, MacDraw, and spreadsheets, for example. Very few users would be prepared to carry out the extensive rekeying required to transfer this information to Hypercard.

Apple will supply the Hypercard software at no extra charge as part of the basic software for all new Macintoshes. This initiative has prompted other suppliers to provide hypertext-type products. For example, IBM France announced its Hyper Document software for the PS2 at the 1987 Paris Automobile Show. This may seem a strange venue to announce such a product, but the first user will be Renault, which is replacing its current dealer-reference material with a system based on Hyper Document.

Other hypertext-like products include the online documentation system for the Symbolics workstations, and a product from Boston Documentation

Design that provides hypertext help facilities for Lotus's 1-2-3 and Agenda applications. We believe that many more hypertext-like products will become available over the next five years. These products are likely to lead to substantial changes in the ways in which computer systems are used.

## SUMMARY

In this chapter, we have emphasised the growing importance of workstations in the overall corporate computing architecture. This will mean that, in many situations, intelligent workstations interlinked via a local area network that provides them with access to data and printing facilities will be able to implement many of the computing functions handled today by departmental minicomputers. We have also shown that the cost of workstations is set to fall in real terms by at least one-third. Finally, we have highlighted the emerging application areas that will further promote the use of workstations.

# Chapter 5

# The implications for Foundation members

The combination of easier-to-use workstations with a more important role for them implies that workstation users will need a much higher level of service and support than was necessary (or forthcoming) when workstations were standalone and truly personal. We believe that the systems department and the equipment suppliers have a joint responsibility for providing the service and support that is now required.

The systems department's responsibility is to determine how best to incorporate personal workstations in the organisation's overall systems architecture, and to provide the appropriate policies and user support to ensure the chosen approach is successful.

The suppliers' responsibility is to provide products that allow transparent and simple access to all parts of an organisation's information-processing network. The extent to which the suppliers fail to meet this responsibility will determine the level of user support required from the systems department.

Thus, to ensure that users obtain the maximum business benefit from using workstations, the systems department must recognise the increasing importance of personal workstations and must take account of their implications in all its planning activities. The systems department must also be prepared and able to make up for the inevitable shortcomings of workstation equipment. Unfortunately, many systems departments have paid insufficient attention to the problems and aspirations of their workstation users, and, as a consequence, lack the skills and motivation to adopt the approach we recommend. We urge Foundation members to assess whether their systems departments are prepared for the move to linked intelligent multifunction workstations. If not, now is the time to take action. In particular, a change in attitude is required — away from a mindset that considers users' PC activities as being of little concern to the systems department. In doing this, it will probably be necessary to re-appraise the advisability of a separate workstation support unit (or information centre). Such units have tended to isolate workstations and their users from the mainstream activities of the systems department. We believe the time has come to adopt an approach that recognises that workstations are an integral part of the organisation's computing activities.

## MUCH HIGHER LEVELS OF SUPPORT WILL BE REQUIRED

Throughout this report, we have emphasised that workstation users want to be able to interact with data held on any relevant processor (internal or external), but especially mainframe processors, in as simple and inexpensive manner as possible. In particular, they want the interaction to take the same form regardless of the types or makes of processors or the software they run.

The implications of these simply stated requirements could not be more far reaching, because they will have a significant impact on everything that is controlled by the systems department — the user interface, operating systems, system development, data, and networks. We believe that the only way the requirements can be met is by the systems department recognising and responding to the increased influence that the personal workstation now has on the organisation's overall information technology plans and policies. This means taking workstations into account in deciding:

- Whether processing and data storage should be local or remote, distributed or centralised.
- The systems development methods and standards that should be used.
- The networking policy and the design of networks.
- The capacity requirements for the various components of the total information-processing network, and the implications in terms of the most effective use of capital, revenue, and other resources.

To demonstrate why we feel that the personal workstation must feature so highly in areas of corporate concern, we need to discuss each area of the systems department's responsibility in turn.

### THE USER INTERFACE

In practice, many organisations already have some form of user-interface 'standards' — standard

layouts for transaction-processing screens, for example, and implicit standards for office systems, usually expressed as product preferences. However, these standards were usually set when user-interface technology was much more primitive than it is today, and new standards are now required for the much improved user interfaces that are now available. The systems department needs to define a policy that ensures there is a consistent user interface across all of the organisation's systems. The policy should include training, programming support, and a plan for implementing the policy. The policy can be defined in one of three ways:

- Impose a single-vendor, single-workstation policy, and purchase all workstation software from the same software company. This approach addresses only part of the problem since software for other (nonworkstation) processors is likely to have been provided by other suppliers and will interact differently with workstation users. Even if a product like Ashton-Tate's dBase III is used on workstations and other processors, there will still be applications that have to be developed using other software — mainstream transaction-processing applications, for example. Furthermore, this approach is only viable in the short term — it will last only as long as the chosen workstation vendor maintains complete compatibility from one generation of hardware and software to the next. In addition, this approach will exclude the organisation from the product innovations developed by other vendors. In reality, most user organisations already have a multivendor policy and it would be very costly to reverse this. More importantly, perhaps, we do not believe that workstation users in the 1990s will tolerate the restrictions imposed by a single-vendor policy.
- Develop and maintain bespoke in-house standards for the user interface. At first sight, this is the most attractive policy option because the resulting interface will have been designed specifically to fit the characteristics and culture of the organisation. However, the practical difficulties of implementing such a policy probably exclude it as a serious option. Most organisations do not have systems staff with the experience and expertise required to develop and support such a project. A further disadvantage is that this approach would necessitate the use of bespoke applications software throughout the organisation, or would require very complex bridges to impose the bespoke user interface on proprietary application packages.
- Adopt an industry-standard for user interfaces (for all applications, not just workstation applications). We believe that this is the only practical option. However, at present no such standard exists. The only prospective standard is the common user access element of SAA. Although SAA is being defined by IBM, the common user access standards will be nonproprietary and, in time, we expect other suppliers to adopt them. However, as we explained in Chapter 3, SAA is at present ill-defined and is still evolving. It will be several years before the SAA standards are widely used, even within the IBM product range. Another disadvantage of adopting this approach is that it will take an organisation several years to update existing applications so that they conform with the new standard.

In reality, it may not be practical today to adopt any one of these approaches completely. Instead, a more pragmatic approach may be necessary. For example, it might be sensible to define a common user interface policy for intelligent workstations (where the interface can be controlled by the workstation software), whilst recognising that it will be impractical to change the user interface on dumb terminals (where the interface is controlled by mainframe software).

Regardless of the user-interface policy option that is chosen, it is clear that the systems department is the only unit in the organisation capable of making the choice and of understanding and responding to its implications. Implementing a consistent user-interface policy will require considerable planning and the provision of substantial support. The systems department will need to:

- Develop a training programme that explains the user interface and how to write programs in accordance with it. Different training courses will be required for the user community and for systems staff.
- Determine the policy for rewriting existing applications. There is little point in specifying a common user interface if most applications do not use it. All applications software is rewritten eventually — but the systems department will have to decide whether there are some applications that should be rewritten (or enhanced) sooner rather than later to provide the benefits of conforming to a common user interface.
- Decide the level of programming support that should be provided for personal workstation users. In the past, workstation (or PC) users have been quite happy to develop and implement their own spreadsheet (and other) applications. In fact, one of the motivating forces behind the growth in the use of standalone PCs has been the feeling of independence that PCs have given users.

However, their attitude may well change when they are asked to conform with an overall corporate standard and this may well shift the emphasis of workstation applications development to the systems department.

- Decide whether to standardise on one particular keyboard or to allow specific keyboards to be used for specific purposes. In the latter case, the common-user-interface policy could be retained by the systems department providing keyboards that can be reconfigured under software control.

#### OPERATING SYSTEMS

Foundation members should make a positive decision about whether (and when) to move to the new OS/2 workstation operating system and should ensure that sufficient resources and training are provided for the decision to be implemented. As discussed earlier, we believe that now is the time for user organisations to decide what, if anything, they are going to do about OS/2. Clearly, the decision on whether to change to a new operating system is important. We believe that this decision should be made as soon as possible. If it is not, there is a possibility that, in time, the organisation will be using an obsolete operating system and will have to take hasty action for which it is unprepared.

Regardless of whether the decision is to stay with the current operating system or move to OS/2, there will be implications for the systems department. The risk of staying with the existing operating system is that the supply of applications packages, and support for existing packages, will dry up. In this case, the systems department will need to plan for the continuing support and development of the workstation software base. This may be expensive — but so is the alternative of changing to a new operating system.

If the decision is to change to OS/2, then further decisions will be required about how best to implement the change and over what timescale. The factors that need to be considered are similar to those discussed above for implementing a common-user-interface policy. Thus, the systems department needs to specify:

- A migration policy that determines which programs will be rewritten to take advantage of the new operating system features, and which will be run under some form of emulation and for how long. (Products are already available to allow existing MS-DOS programs to run under OS/2.) Both approaches will require support from systems staff either to rewrite (or to assist the users in rewriting) programs so they can run under OS/2, or to cope with the inevitable problems that will arise from the implementation of an emulation product.
- A training programme that has at least three segments — an explanation of OS/2, its implications, and how to write applications under it (this segment will be aimed both at users and at systems staff); an explanation of the emulation product, how to use it, and what to do when problems arise; and details about the applications rewritten to run under OS/2, how they differ from the original versions, how to convert data files so they can be used with the new versions, and how to make the most effective use of the new versions.

#### SYSTEM DEVELOPMENT STANDARDS AND PROCEDURES

Without appropriate development standards and procedures, it will not be possible to ensure that the interaction between workstation users and data sources is simple and consistent. The systems department should specify standards and procedures that permit hardware-independent programs to be written and that permit application-to-application communications. The standards and procedures should be backed up with the appropriate training and support to make them work. In addition, the department must define its policy for deciding whether applications processing will be performed at the workstation or on other corporate computing resources. The programming standards should be defined to support this policy. They should also take into account the new applications for workstations, such as structured mail, expert systems, and hypertext.

Many organisations already have system development standards, but the existing standards are invariably specific to a particular hardware and operating-system environment. As a consequence, most organisations today have several standards — one for each environment. However, if the user requirements identified in Chapter 2 are to be satisfied, it will be necessary to have one set of development standards that applies to all combinations of hardware and operating systems. The options for developing such a set of standards, and their advantages and disadvantages, are very similar to those for defining a common user interface:

- Adopt a single-vendor policy that encompasses workstations and all other types of computing equipment and select applications that have been developed to run across the full range of equipment. In theory, this should allow applications developed for workstations to run on other equipment, and vice versa. Inevitably, however, there will be situations where the workstation version of a proprietary package

has only about 80 per cent of the functionality of the mainframe version. Furthermore, the missing 20 per cent will inevitably contain the most significant features from the users' point of view. In these situations, the systems department must be prepared (and able) to overcome the shortcomings of the workstation software.

- Develop and maintain bespoke in-house application-to-application communications standards. Unless the organisation is active in defining international standards or is a major vendor of proprietary applications software, this option should not even be considered.
- Adopt an industry standard for application-to-application communications. Again, no such industry-wide standard currently exists.
- Choose a preferred workstation (or a small range of workstations) and interworking standards, and support the development of gateways to other environments. Again, this is a pragmatic approach that recognises the differing strengths of various workstation products, and the need to interwork with a range of existing software environments. This approach also exploits the existing *de facto* standards for interworking whilst allowing new standards to be adopted in the future. The disadvantage is that it is costly and requires considerable continuing support for communications gateways and other conversion systems.

We believe that most organisations will find themselves choosing between the third and fourth options — balancing short-term and long-term advantages against cost and risk. Whatever the choice, there will be implications for the systems department. In particular, the systems department will need to:

- Update its current development standards and tools, and retrain its staff in the implications and use of them.
- Update its policy for deciding which processing should be done at the workstation and which should be done elsewhere. The policy should take account of the ability to write hardware-independent applications and to interwork between applications. It should also take account of the increased significance of workstations in the overall computing architecture. The policy will help to decide, for example, if the processing for mail and messaging applications should be on a host computer, a minicomputer, or a server; or if screen-intensive applications should run on personal workstations and processor-intensive applications should be on a server. These, and the many other related considerations, will need to be thought out thoroughly and the results of the deliberations fed through to the capacity-planning and development-planning processes.
- Develop a training programme to teach workstation users about the new programming practices, and provide additional support for those users who are uncertain about what they have to do in order to comply with the new standards.
- Provide specialist support to identify and resolve the problems that arise when it is necessary to depart from the standards (to support PL/1 applications in the SAA environment, for example) or when users decide (as some inevitably will) that they no longer wish to develop their own applications.
- Ensure that a standard set of conventions and preformatted layouts for structured electronic mail applications are developed, promoted, used, and maintained throughout the organisation. It is vital that such a standard is established. If different groups start to use their own conventions and layouts then their structured-mail messages will not be in a form where they can be processed automatically by the rest of the organisation.
- Set up an expert systems support unit, as per our recommendations in Foundation Report 60. Such a unit can ensure that an expert system that will be used widely throughout the organisation (such as guidance on how to comply with the budgeting procedures, or advice on desktop publishing design and layouts) has been developed professionally. In this way, the unit can ensure that exactly the same version of the expert system, with the same user interface, is used throughout the organisation.
- Consider the implications of hypertext systems, in particular to determine how best to benefit from their use without incurring the high penalties (in terms of processing power and data storage) that their uncontrolled use could cause.

#### DATA

To be able to ensure that the personal workstation becomes the entry point to all data, the systems department may well need to review its data-management and database policies. These policies should ensure that it is possible to determine where best to store data, how to make it secure, and how to make it meaningful to all users.

In Chapter 4, we predicted that the personal workstation of the future will be an integral component of the overall corporate computing architecture. In particular, we predicted that the

personal workstation of the future will be disc-less, with all data access being managed via file servers. The disc-less workstation has profound implications for the systems department and its data architecture. Implementing the required data-architecture policy will require considerable preparation and support. The systems department will need to:

- Review the technical strategy to ensure it includes workstations and servers, and, if necessary, revise the procedures for deciding where data should be stored.
- Prepare a data-conversion plan for transferring data from where it is currently stored, coordinating the moves with any changes occurring in the user interface and programming standards.
- Determine the data-security practices that are required, in particular for deciding the access rights for different types of users. The practices should also cover data-consistency issues and set out the rules about who is allowed to program the file servers. They should also specify the back-up procedures and the procedures for recovering after a hardware or software failure.
- Review the data-naming conventions to ensure they are consistent not just within mainframe applications, but right across the whole network (to workstation applications). This means, of course, extending data-analysis, data-management, and data-dictionary techniques across the complete computing architecture. It also means that the systems department must be aware of the data that is being stored at any point on the network and the purposes for which it is being used.
- Decide the level of support that is required to underpin the new policy and practices, and to resolve the inevitable problems that will result from departures from the standards.

#### NETWORKS

Many of the support problems that need to be resolved before workstation users can access a variety of data sources via the corporate network have already been discussed in the preceding sections. The only additional factor that we need to emphasise here is the need to take workstation users into account when corporate network plans are reviewed. The increasing emphasis on shared resources, on downloading data to workstations, on electronic mail, and on the transmission of text (and possibly image) all suggest that there will be a growing demand for telecommunications. In turn, this implies an even greater need for effective network planning and management in order to avoid unnecessary bottlenecks.

### THE SYSTEMS DEPARTMENT IS NOT ORGANISED TO PROVIDE THE REQUIRED SUPPORT

The increased support requirements described above mean that the systems department will have a much greater responsibility for managing the way in which workstations are used throughout the organisation. (At present, the use of PCs is largely controlled by user departments.) Unfortunately, our research (which is detailed in the appendix) suggests that most systems departments are ill-equipped to take on the expanded responsibility. For example:

- Most workstation policies are technical in nature, concentrating on products and vendors. Their aim is to restrict the users' choice; they do not take account of users' requirements or the underlying architecture or standards issues.
- Most workstation policies do not cover programming languages and back-up and recovery procedures. We believe that this stems partly from a belief that workstations are personal tools, and that users should therefore be responsible for setting up their own procedures, and partly from a belief by systems staff that the new development tools used with workstations are not worthy of their consideration.
- Most workstation support units (or information centres) provide tactical help (in selecting equipment, for example) and operational support (usually via a help desk), rather than strategic support.

These, and other examples, led us to consider how support for workstation users should be provided by the systems department — the type of support that is required and how it should relate to the rest of the systems department. In doing this, we examined the way that a typical systems department is structured today and we believe we have identified three major organisational problems that will have to be overcome before effective support for workstation users can be provided. In summary, the problems are:

- Workstation users today have to deal with a bewildering variety of systems staff.
- The workstation support group (information centre) is usually regarded by the rest of the systems staff as not being part of the mainstream activities of the systems department.
- The workstation support unit is not involved in formulating the organisation's overall information technology plans.

#### WORKSTATION USERS HAVE TO DEAL WITH TOO MANY SYSTEMS STAFF

The traditional demarcations between the various functions in the systems department mean that workstation users are never quite sure who they should contact to help them solve a particular problem. Business analysts liaise with users for mainframe and distributed-processing applications — but usually not for workstation applications. The data centre help desk provides on-the-spot assistance for users with mainframe and distributed-processing problems (there may in fact be a different help desk for each area) — but not with workstation problems. The workstation support unit liaises with users for workstation problems — but not for mainframe and distributed-processing problems. These piecemeal arrangements were adequate whilst most workstations were used for a single purpose and were not interlinked. They will not work in a multifunction, interworked environment because workstation users will not know who to turn to for advice about a particular problem.

#### THE WORKSTATION SUPPORT GROUP IS NOT PART OF THE MAINSTREAM SYSTEMS DEPARTMENT

Often, the workstation support unit (or information centre) is regarded by other systems staff as not really being part of the systems department. This perception probably results from the reasons for establishing a separate workstation support unit in the first place. As the number of PCs proliferated in an organisation, the systems department began to worry about how to control them. Users were beginning to acquire their own equipment and build their own applications. As users became more confident in using the technology, the power and influence of the systems department began to decline. The inevitable response by the systems department was to take steps to support and control the PCs that were being installed in large numbers — hence the formation of the workstation support group.

Unfortunately, the support requirements were very different from those that the systems department was used (or equipped) to providing. The workstation environment is characterised by a much faster rate of change than the traditional mainframe environment, and development projects are much shorter. Traditional data processing methods, techniques, and tools were not suitable for supporting workstation users. Thus, the setting up of a separate workstation support unit was an admission that traditional data processing methods were inadequate. To succeed, the workstation support unit therefore had to be established as a peripheral activity as far as the rest of the systems department was concerned.

Thus, the initial gap between the systems department and the workstation support unit was established and that gap has since grown substantially. The staff appointed to the workstation support unit were often the technical 'mechanics' of the systems department — more concerned with installing equipment and with the intricacies of the latest technology than with whether an application was really suitable for a workstation at all. Their colleagues, who did not think highly of them, tried to restrict their activities — by prohibiting them from programming, for example. If a workstation user required programming support, he or she had to take their chance in the traditional systems development queue. This type of attitude has led to many workstation users expressing concern about the lack of support from systems development staff. (Our own research, detailed in the appendix, confirmed this concern.) Thus, workstation users and workstation support staff had a common enemy, and this strengthened their relationship, and further alienated both groups from the rest of the systems department.

The result is that, today, many workstation support staff do not consider the other computing interests of the organisation, and the rest of the systems department often pays insufficient attention to the interests of the workstation support unit and its users.

#### THE WORKSTATION SUPPORT UNIT IS NOT INVOLVED IN FORMULATING INFORMATION TECHNOLOGY PLANS

More often than not, the workstation support unit's staff are not involved in formulating the organisation's overall information technology plans. They may provide some input to the planning process, but this is usually restricted to predicting the likely increase in the number of workstations for budgeting purposes. Because of the alienation of the workstation support unit from the rest of the systems department, the unit's staff are not invited to express their views about the evolving role of the workstation and the fundamental effects that it will have on every aspect of the organisation's computing activities.

All of these organisational problems must be resolved before the personal workstation can become the effective multifunction single entry point to the organisation's information-processing network. In particular, we believe that the workstation support unit's responsibilities must become an integral part of the systems department's activities.

### PREPARING FOR THE WORKSTATION OF THE FUTURE

The first priority is to begin the process of integration referred to above. Without such an organisational change, user organisations will not be in a position to recognise and respond to the challenges that will result from the changed role

and importance of the workstation. The organisational change required is not just to reposition the workstation support unit within the systems department. Instead, it probably requires the concept of a separate workstation support unit to be abandoned altogether, with workstation support and services being provided by the systems department's functional areas. These areas will have to provide much better service (especially in the time taken to develop and implement new applications) than they have been used to — but by adding workstation techniques and tools to their portfolio of skills they should be equipped to accept the additional responsibilities.

In determining how best to prepare for the multifunction interlinked workstations of the future we recommend that Foundation members carry out four actions:

- Establish a business support function.
- Use workstation techniques and tools for systems development.
- Provide a single help-desk contact point for workstation users.
- Recognise the importance of lead users.

#### ESTABLISH A BUSINESS SUPPORT FUNCTION

We recommend that the systems department establish a business support function that is responsible for ensuring that information technology is deployed in the best interests of the organisation as a whole (that is, in such a way that it has the maximum possible impact on the bottom line). To fulfill this responsibility, the business support function will have to perform two main roles — planning and user liaison. The two go hand-in-hand. The business support function cannot plan without understanding users' business requirements and objectives. Thus, business analysts will work with all users, regardless of whether their computing is based on mainframes, minicomputers, or workstations.

The business support function should also be responsible for user training and for data management because:

- Business analysts working with users are in a good position to determine the training that would improve the liaison between users and the systems department and would enable users to make the best use of all the organisation's computer facilities. Users are more likely to respond to training programmes designed and presented by the business analysts with whom they have a close working relationship rather than by a general training unit.
- In a corporate information-processing network, someone has to decide whether applications should be processed on workstations or mainframes and whether data should be held locally or remotely. To do this, the individuals concerned must be aware of the data that is held, and who is responsible for it, and of the processing that is carried out at various points in the network. Data-management staff located in the business support unit will be ideally placed to gather this information.

Thus, the business support function will contain staff who are responsible for ensuring that there is a common user interface throughout the organisation, for ensuring that programming standards and procedures are adhered to, and for defining the data and communications policies (systems architecture). These staff will work closely with the systems strategists to develop and maintain the overall information plan and framework. Furthermore, we believe that the business support function should absorb existing workstation support staff — broadening their horizons in the process.

Care needs to be taken, however, to avoid the workstation support activities being relegated to a minor role once the support unit loses its separate identity. There is a danger that conventional systems staff will tend to concentrate on what they see as their main concern — the mainstream data processing activities. This danger can be avoided by differentiating between those staff that handle planning activities and those whose skills lie more in face-to-face contact with individual users. However, both kinds of staff would need to be aware of the variety of methods available to solve any given problem.

#### USE WORKSTATION TECHNIQUES AND TOOLS FOR SYSTEMS DEVELOPMENT

All systems development departments should have a wide range of techniques and tools from which they can select, depending upon the nature of the application that faces them. In future, such techniques and tools will be chosen to ensure that the resulting applications conform with the overall user-interface and programming standards adopted by the organisation. We believe that the best way of adding workstation techniques and tools to the more traditional development methods is to absorb the existing workstation support staff and their skills, experience, techniques, and tools into the systems development function. As a result, the resistance of systems development staff to using workstation techniques will begin to break down, and the use of advanced system building tools pioneered by workstation support staff (and users) will begin to have an impact on traditional development areas.

In Foundation Report No 47 (The Effective Use of System Building Tools), we predicted that advanced fourth- and fifth-generation languages would become the usual development tools, with the more traditional tools being used in special circumstances only — for example, for high-volume/high-performance applications or for the maintenance of existing applications. We believe that this is still the case, but that it will come about only after the conservative views of existing development staff have changed. Our proposal to absorb workstation support staff into the systems development function will go a long way towards changing the attitudes of traditional development staff.

#### PROVIDE A SINGLE HELP DESK CONTACT POINT

We believe that, regardless of the nature of their problem, users should always be able to contact just one point in the systems department to ask for help. In a large organisation, there may indeed be several help desks — but a particular user should always be able to contact the same desk. Staff working on the help desk should be able to resolve most problems immediately. (Surveys have suggested that most users' operational problems are concerned with knowing which key to press next, or even with difficulties in switching the equipment on; all of these problems can be resolved over the telephone.) However, there will be some problems that have to be referred to experts within the systems department. The help-desk staff should ensure that this happens, and should chase the progress that is being made and report back to the user as quickly as possible with the answer. The user should never be asked to telephone someone else. The help desk should also be responsible for collecting and analysing statistics about the problems that occur, and should provide the relevant managers in the systems department with information about trends that may suggest the need for remedial action in a particular area.

For the help desk to function in the way just described, it must be properly resourced and fully supported by management. A recent survey by Xephon of 81 installations in the United Kingdom, suggested that 70 per cent of help desks are manned part-time by staff who are expected to perform other duties at the same time. In more than 40 per cent of the installations, none of the help-desk staff had received any training in their role. As a result, most users ignore the help desk and telephone their private contacts elsewhere in the systems department. Such a state of affairs cannot be allowed to continue if workstation users are to be properly served in the future.

#### RECOGNISE THE IMPORTANCE OF LEAD USERS

All organisations that use information technology have some users who become so interested and motivated that they gain significant practical experience and eventually begin to advise their colleagues, albeit unofficially. In most cases, they spend more of their time providing advice about information technology (and particularly workstations) than they spend on their official job. To date, most systems departments have tended to belittle the efforts of these individuals and have delighted in ridiculing them should an appropriate occasion arise. Such an attitude is pointless and wasteful — pointless because such individuals will exist with or without the blessing of the systems department; and wasteful because such users have an important role to play. It is often easier for a computer-literate business colleague to help someone who has a problem with using a workstation than it is for the help desk to assist. Often, the problems are nothing to do with technology as such. Instead, they are usually concerned with the way a business professional structures a business problem so that information technology can be used to resolve it. A computer-literate colleague is in the best position to help in such situations, and we recommend that the role of lead users is formally recognised and supported by the systems department.

## REPORT CONCLUSION

In this report, we have shown that the overall requirement of workstation users is to be able to interact with information held on any relevant processor (internal or external) in a consistent, simple, and inexpensive manner. Many of today's workstation products are seriously lacking in this respect, but we have shown that the suppliers are working to remedy many of the defects.

However, easier-to-use (and less-expensive) equipment is only part of the answer. In order to meet the users' requirements, systems departments will have to recognise that the workstation is a vital component of the overall corporate information-processing network and must be given due consideration in all information-technology planning activities.

This recognition is likely to come about only if the management of workstation use and the support of workstation users is absorbed into the mainstream activities of the systems department. This may well require the concept of a separate workstation support unit (or information centre) to be abandoned, with the workstation unit's skills being dispersed amongst the rest of systems department's functions. However, the level of support required will increase substantially as workstations are used for a variety of functions and are interlinked to each other and to other corporate computing

resources. Systems departments therefore need to invest heavily in providing the right level of service and support for workstation users, and will have to abandon traditional practices in order to do this.

The inevitable result of these conclusions is that the workstation of the future will cease to be just a personal tool used by individuals to help them to do their jobs better. Instead, it will become a vital component of the organisation's overall computing architecture, allowing users to access any other computing resource or data in a consistent and trouble-free manner.

# Appendix

# Detailed survey findings

During our research for this report we interviewed and spoke both with the suppliers of workstations (hardware and software) and with workstation users (systems staff and end users). In conducting the user interviews, and in the questionnaire sent to Foundation members at the start of the research, we set out to gather quantitative data that could be used to support our conclusions. Clearly, we were not attempting to carry out an extensive survey that would provide reliable and detailed forecasts of the world market for workstations over the next five years. Nevertheless, we believe that the data we gathered is representative of the current and future usage of workstations and does provide evidence of the general trends. In the report, we have referred to the main results of the data analysis where they are relevant. In this appendix we include the more detailed results from our analyses. We first summarise the characteristics of the two sources of quantitative data, and then present the detailed findings that support the main conclusions of the report. The findings are grouped under four main headings:

- Workstation types and penetrations.
- The functions for which users want to use workstations.
- The underlying technical requirements.
- Current workstation technical policies and support facilities.

## THE COMPOSITION OF THE TWO SURVEYS

We collected data from two sources: the questionnaires returned from 134 Foundation members at the outset of the research; and the data collected from 44 different user organisations as part of the interview and focus group meetings carried out during the course of the research. Thirty-eight of these provided us with detailed statistics, which form the basis of most of the charts and figures in this appendix. Figure A.1 analyses the replies to the questionnaire by country and business sector. Figure A.2 shows the characteristics of the organisations that provided data in the interview programme.

**Figure A.1 Analysis of Foundation members that responded to the questionnaire distributed at the beginning of the research**

**134 replies were received**

| Country or region | % of replies |
|---|---|
| Australia and the Far East | 8 |
| Belgium and the Netherlands | 12 |
| France | 15 |
| Italy | 6 |
| Scandinavia | 3 |
| United Kingdom | 53 |
| Other | 3 |

| Business sector | % of replies |
|---|---|
| Banking and financial services | 29 |
| Chemicals, minerals, and manufacturing | 17 |
| Food, consumer goods, and retail | 15 |
| Publications utilities, energy, and transportation | 14 |
| IT industry | 12 |
| Government | 10 |
| Other services | 3 |

Both sources included a representative sample of organisations from different business sectors. For example, among the organisations interviewed, the five largest populations of personal workstations (over 10,000 terminals) included a French bank, a large German manufacturing company, an airline, a government department, and a public utility. The smallest populations of workstations (less than 500 terminals) were found in all industry sectors, but with a slight emphasis on retail organisations — probably because we excluded supermarket checkout terminals from our definition of workstations

**Figure A.2 Analysis of user organisations that provided workstation data during the interviews**

| Business sector | % of organisations |
|---|---|
| Banking and financial services | 29 |
| Public utilities and other services | 29 |
| Manufacturing and construction | 26 |
| Government | 11 |
| Retail | 5 |

| Number of office staff | % of organisations 1988 | 1993 |
|---|---|---|
| Less than 100 | 10 | 6 |
| 101 to 1,000 | 27 | 37 |
| 1,001 to 10,000 | 23 | 20 |
| More than 10,000 | 40 | 37 |

There are about 450,000 office staff in the organisations interviewed

| Number of workstations | % of organisations 1988 | 1993 |
|---|---|---|
| Less than 100 | 8 | 5 |
| 101 to 1,000 | 45 | 37 |
| 1,001 to 10,000 | 34 | 37 |
| More than 10,000 | 13 | 21 |

There are about 145,000 workstations in the organisations now, and they expect to have about 215,000 in 1993

## WORKSTATION TYPES AND PENETRATIONS

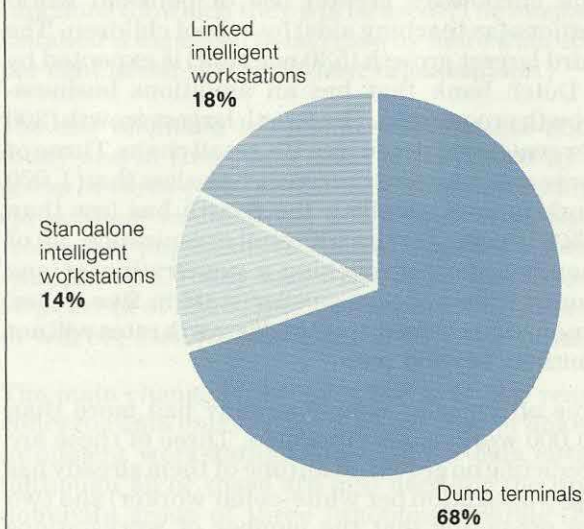
Figure 2.2 on page 5 showed the penetration of personal workstations in our sample of user organisations. Thirty organisations were able to provide accurate data; overall, they currently have one personal workstation per three-and-a-half white-collar workers. This average is clearly biased by two organisations (a bank and a retail chain) that have less than one personal workstation per 18 white-collar workers. When the data from these two is ignored, the average penetration increases to one personal workstation per two-and-a-half white-collar workers.

Our analysis by industry sector shows that the workstation penetrations for all sectors cluster around the average, except for banking and retail. The variations from the norm for these industries would be less if we had included banking terminals and checkout terminals in our definition of workstations.

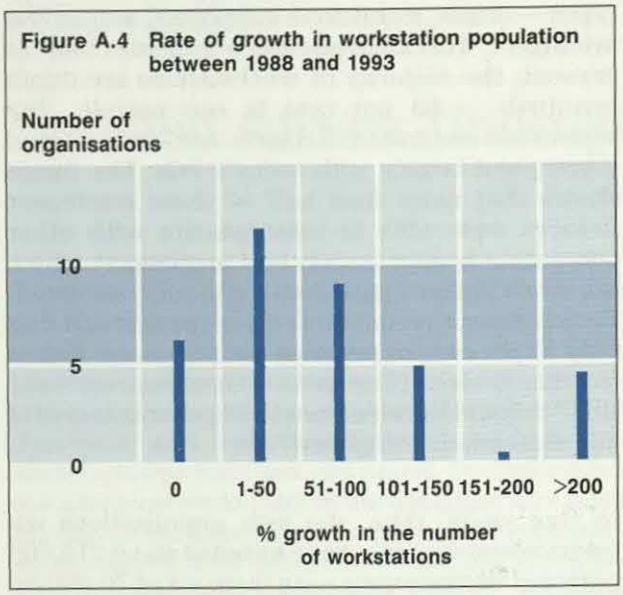
Figure A.3 shows how the 145,000 personal workstations in our sample of user organisations were distributed amongst the three workstation types — dumb, standalone intelligent, and linked intelligent. This analysis clearly indicates that, at present, the majority of workstations are dumb terminals — 68 per cent in our sample. The standalone and linked intelligent workstation types correspond largely with today's PCs. The figure shows that more than half of these intelligent devices were able to communicate with other computing devices (mainly host processors), which is a much higher figure than is generally assumed. For example, a recent conference speaker said that only 15 per cent of personal computers are linked to other devices. (The speaker then went on to say that "a standalone personal computer is as useful as a standalone telephone".)

In five years' time, the user organisations we interviewed expect to have installed about 215,000 personal workstations — an increase of 70,000 on today's installed base, representing an overall growth of 48 per cent over five years, or an annual compound growth of 8 per cent. Figure A.4 overleaf shows the expected rates of growth in the number of workstations installed in these organisations. Seven of them are expecting no growth at all — three of them (two manufacturing companies and a government department) already have one personal workstation per white-collar worker; the other four (a manufacturing company, a bank, and two public utilities) believe they cannot cost-justify higher penetrations than those already reached. A further 13 organisations (just over a third of our

**Figure A.3 Today, most workstations are dumb terminals**




Analysis of 145,000 workstations installed in 38 Foundation members




sample) are expecting no more than 50 per cent growth over the next five years — that is, about 8.5 per cent annual compound growth.

At the other end of the scale, four organisations are expecting the number of workstations to increase by more than 200 per cent growth over the five years (equivalent to 25 per cent annual compound growth). The largest predicted growth is 900 per cent, but the circumstances of this particular company are exceptional in that it has been in existence only for 18 months and, therefore, the growth in workstations will be due to growth in the workforce rather than to increased penetration. The next highest growth (655 per cent) is expected by a local-government authority. In this case, most of the growth will be caused by an education policy that encourages greater use of personal workstations (as teaching aids) by school children. The third largest growth (530 per cent) is expected by a Dutch bank that has an ambitious business-growth programme. The fourth largest growth (300 per cent) is expected by a UK retail chain. Three of these organisations currently have less than 1,000 workstations installed; the fourth has less than 2,500. Except for the UK retail organisation, all of them will be approaching a penetration of one workstation per white-collar staff in five years' time and, therefore, their high growth rates will not continue beyond then.

Five of our user sample already had more than 10,000 workstations installed. Three of these are predicting no growth at all (one of them already has one workstation per white-collar worker) and two are predicting that the number of workstations installed will increase by less than 10 per cent annual compound growth.

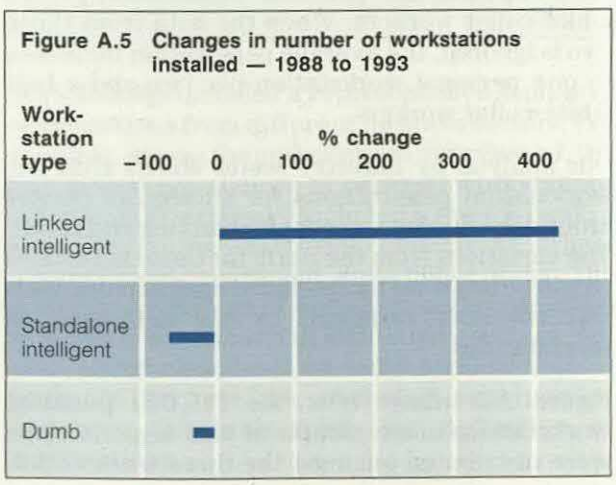
Thus, the overall annual compound growth of only eight per cent results from a combination of low growth rates for those organisations that already have a large number of workstations and high growth rates for those that currently have a small number.

Figure 2.2 on page 5 also showed the expected penetration in five years' time of personal workstations in our sample of user organisations (35 of whom provided data for the analysis shown in the figure). Overall, these organisations are predicting that they will have one personal workstation per two white-collar workers — nearly double the average penetration today. However, 15 of the 35 organisations expect to have installed one workstation per white-collar worker within five years; the remaining 20 believe they will never achieve this penetration — mainly because the cost of doing so could not be justified.

Our analysis of the expected penetrations by industry sector shows that the largest increase is expected in the retail industry, with a four-fold increase, followed by government services and banking, each approaching a two-fold increase.

Figure 2.1 (on page 4) showed how the projected population of 215,000 personal workstations is expected to be made up from the three types of workstation, and compared this with the equivalent data for today's population of 145,000 workstations. That figure showed there is expected to be a significant shift from dumb terminals to intelligent linked workstations. The extent of the shift is even more pronounced when the actual and expected numbers of each type of workstation are compared (see Figure A.5). Over the five-year period, the number of intelligent linked workstations installed is expected to increase by nearly 420 per cent (equivalent to 33 per cent compound growth a year). During the same period, the number of dumb terminals installed is expected to reduce by 30 per cent, and the number of standalone devices by 60 per cent.

One implication of the changes depicted in Figure A.5 is that organisations will be replacing substantial



numbers of existing dumb terminals and standalone workstations with linked intelligent workstations, whilst also increasing the total number of workstations installed.

## WORKSTATION FUNCTIONS

Our detailed interviews with the 38 user organisations show they are expecting a significant change in personal workstation functions over the next five years. The changes for each type of workstation (dumb terminals, standalone intelligent workstations, and intelligent linked workstations) were summarised in Chapter 2 in Figures 2.4 to 2.6. Here we provide additional details about the current and projected use of each type of workstation.

### DUMB TERMINALS

Today, the predominant use of dumb terminals is for data entry with more than 99 per cent of this type of workstation performing this task. In five years' time, the total population of dumb terminals is expected to have reduced by about 30 per cent, and by then all of them will be used for data entry.

Some dumb terminals are also used for host-based electronic mail (11 per cent of the total today; 15 per cent in five years' time). The fact that all the terminals used for electronic mail also perform data entry suggests significant vertical penetration of electronic mail through the structure of the organisations concerned.

A few hundred of the dumb terminals are currently used for host-based word processing. About half of these are used as dedicated word processing terminals; the rest are used for word processing, electronic mail, and data-entry functions. Host-based word processing is expected to have disappeared in five years' time, however.

At present, about 5 per cent of dumb terminals are used for host-based CAD/CAM functions. This single-function use of dumb terminals is also expected to disappear within five years.

In summary, most dumb terminals today (more than 88 per cent) are used as a single-function device, most of the remainder are used for two functions, and a very small proportion is used for three functions. In five years' time, although the population of dumb terminals is expected to reduce, the proportions used for single and dual functions will not change significantly (85 per cent and 15 per cent respectively). The triple-function use will have ceased, however.

### STANDALONE INTELLIGENT WORKSTATIONS

The predominant use today for standalone intelligent workstations (or PCs) is word processing, with 85 per cent being used to perform this function. In five years' time, 94 per cent of standalone workstations are expected to be used for word processing (although the total population of these devices will have reduced by about 60 per cent).

The next most widely used application for standalone workstations is spreadsheet calculations (67 per cent at present, rising to 92 per cent in five years' time). In all cases where standalone workstations are used for spreadsheets, they are also used for word processing. However, at present, 18 per cent of all PCs are used just for word processing. In five years, this is expected to have diminished to 2 per cent.

At present, 9 per cent of standalone workstations are used for CAD/CAM applications — mostly on single-function technical workstations such as Apollo and Sun. This type of use is expected to all but disappear in five years' time.

In summary, about one-third of standalone workstations are currently used for a single function and about two-thirds are used for two functions. However, a very small proportion are used for three functions (word processing, spreadsheets, and CAD/CAM). In five years' time the total population is expected to have reduced by about 60 per cent, but by then over 90 per cent will be used for two functions (word processing and spreadsheets). The rest will be used as single-function devices.

### LINKED INTELLIGENT WORKSTATIONS

Over the next five years, the most significant growth is expected to occur in the use of linked intelligent workstations — both in terms of the number of devices installed, and in the number of functions for which they will be used. (The number installed is expected to increase by more than 400 per cent in our sample of user organisations.)

The use of linked intelligent workstations both today and in five years' time is dominated by a group of three core functions — word processing, spreadsheet calculations, and downloading data from other processors to the workstation for local manipulation. Today, and in five years' time, about 90 per cent of linked intelligent workstations are, or will be, used for this group of core functions.

The main change in use over the next five years concerns data entry. Today, 46 per cent of linked intelligent workstations are used for data entry (although all of these are also used for the predominate group of three functions). During the same period, some dumb terminals dedicated to data entry will be replaced by linked intelligent workstations that are also dedicated to data entry. The result is that, in five years' time, 18 per cent of linked intelligent workstations will be used for

data entry. However, half of these will be dedicated to data entry, and the other half will also be used to perform the group of three core functions.

At present, only 13 per cent of linked intelligent workstations are used for electronic mail purposes. Over the next five years, the proportion is expected to grow to more than 40 per cent, which represents a very large absolute increase because of the substantial increase in the total population. As today, all workstations used for electronic mail are also expected to be used for the three core functions.

Over the next five years, the use of linked intelligent workstations for office automation functions is also expected to increase enormously, from about 1 per cent to 18 per cent of workstations installed. Functions such as diary management and meeting management will be used to enhance existing functions like electronic mail, word processing, spreadsheet calculations, and downloading data.

In five years' time, desktop publishing is expected to be well established, with 11 per cent of all linked intelligent workstations being used for this function. However, in all cases desktop publishing workstations will also be used for word processing, spreadsheets, downloading data, and electronic mail, implying the need to integrate text and graphics.

The use of linked intelligent workstations for CAD/CAM will also increase, from 3 per cent of all devices today to 11 per cent in five years' time. One significant change, however, is that all CAD/CAM workstations in the future will also have desktop publishing facilities.

There are also some interesting changes in the multifunctional use of linked intelligent workstations:

- The proportion used for a single function will increase from 5 per cent to 14 per cent, mainly because of dedicated data entry.
- At the other extreme, in five years' time, 11 per cent of linked intelligent workstations are expected to be used for six functions — word processing, spreadsheets, downloading data, electronic mail, CAD/CAM, and desktop publishing.
- In five years' time, nearly one-third of all linked intelligent personal workstations are likely to be used for more than four functions. Today, only 4 per cent are used for more than four functions.

#### SUMMARY OF RESEARCH ON WORKSTATION FUNCTIONS

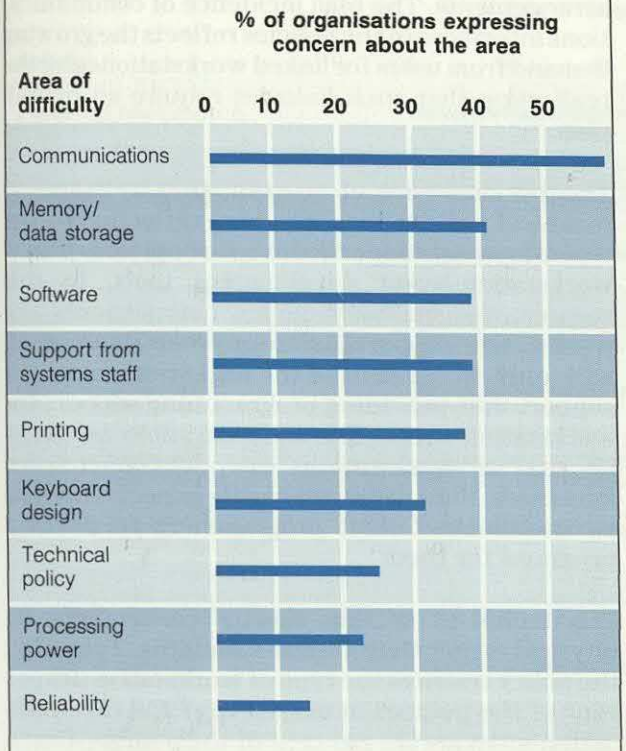
Our research into the functions that personal workstations will be used for in our sample of user organisations can be summarised as follows:

- Over the next five years, dumb terminals will be used mainly for a single function — data entry.
- Over the same period, standalone personal workstations will be used mainly for two functions — word processing and spreadsheet calculations. Standalone CAD/CAM workstations will disappear.
- Linked intelligent workstations will be used extensively to perform a group of three core functions — word processing, spreadsheet calculation, and downloading data. However, there will be significant growth in the use of electronic mail and other office automation functions as additional (rather than separate) functions. A further additional function — desktop publishing — will become important, especially in conjunction with CAD/CAM.
- In five years' time, more than 85 per cent of all linked intelligent workstations will be used to perform three or more functions, and nearly a third will be used to perform five or more functions.

### THE UNDERLYING TECHNICAL REQUIREMENTS

To help us get a feel for the underlying technical requirements for workstations, the questionnaire distributed at the beginning of the research asked Foundation members to state which of various areas of potential workstation difficulty are of concern to them. Figure A.6 shows the results and illustrates that the area of greatest concern is communications, with 59 per cent of the organisations that responded saying they had difficulties in linking workstations to local area networks, host processors, and so on. The next four concerns (memory and data storage, software, support from in-house systems staff, and printing) were each mentioned by about 40 per cent of the respondents. Memory and data-storage concerns relate either to the lack of space available once the systems software has been loaded or to the huge size of some spreadsheet applications — or to both. Software concerns related both to systems software and to applications. Printing concerns related in general to interface problems (the most common complaint being that the image on the screen was not reproduced exactly on the printed page) or to the continued use of electromechanical printers (rather than laser printers) with their inherent noise, low speed, and poor quality. The concern about the lack of support from in-house systems staff is very interesting and has implications for the way in which the systems department manages the use of personal workstations, particularly in the light of user concerns expressed about technical policies

**Figure A.6 Communications was the most frequently mentioned area of difficulty**




(Source: Survey of 134 Foundation members)

for workstations. Twenty-five per cent of the respondents said that the technical and procurement policies laid down by their systems departments were too rigid.

Nearly a third of the respondents were concerned about inconsistent keyboard designs. We believe, however, that this concern is considerably understated — our more detailed interviews showed that two-thirds or more of user organisations are concerned about the lack of a standard keyboard layout. Finally, less than a quarter of the respondents were concerned about workstation processing power, and only 15 per cent were concerned about reliability.

Our understanding of the technical requirements was then refined during the detailed discussions we had with 44 user organisations. During these discussions we explored the difficulties that are encountered in using existing workstation products. We also sought the user organisations' views on the likely commercial significance of some of the more recent and forthcoming product innovations. In analysing the results of these discussions, we calculated a concern rating for problems, and an interest rating for product innovations. The calculations were based on applying a weighting factor depending on whether the organisation's response was 'high', 'medium', 'low', or 'no interest':

- High concern or interest was given a weighting factor of 5. High concern related to an urgent problem that could be resolved only by removing the difficulty; high interest related to an urgent business need that could be satisfied by the product innovation.
- Medium interest or concern was given a weighting factor of 3. A medium weighting related to a problem or a need that could be satisfied by removing a difficulty or introducing the product innovation — but was not an urgent problem or need.
- Low interest or concern was given a weighting factor of 1 and related to a solution or product innovation that could be categorised as 'nice to have'.
- A weighting factor of 0 was given if the problem was of no concern or the product innovation was of no interest.

The overall score for each concern or product innovation was then calculated by multiplying the number of responses in each category by the weighting factor and summing the result. We received responses from 38 organisations, so the maximum possible score was 190 (achieved if all 38 respondents rated their concern or interest as 'high'). The overall score was then converted to a concern or interest rating by expressing it as a percentage of the maximum score. Thus, a concern rating of 100 per cent means that all of the respondents rated their concern with the particular problem as 'high'; and an interest rating of 0 means that all respondents rated a particular product innovation as being of no interest. (The concern ratings in Figure 2.7 and the interest ratings in Figure 2.12 were calculated in this way.)

The overwhelming conclusion is that, over the next five years, the most significant user concern about workstations is ease-of-use. All of the organisations rated ease-of-use as being of high concern. It is also the underlying or consequential concern behind many of the other problems with a high concern rating.

## CURRENT WORKSTATION TECHNICAL POLICIES AND SUPPORT FACILITIES

In the questionnaire distributed at the start of the research, we asked Foundation members if they had a technical policy for workstations, and if they provided a workstation support unit. We also asked about the scope of the technical policy and the nature of the support provided. During our discussions, we asked more detailed questions

about the support unit in an attempt to determine where it is positioned in the systems department and what its relationship is with the other systems functions.

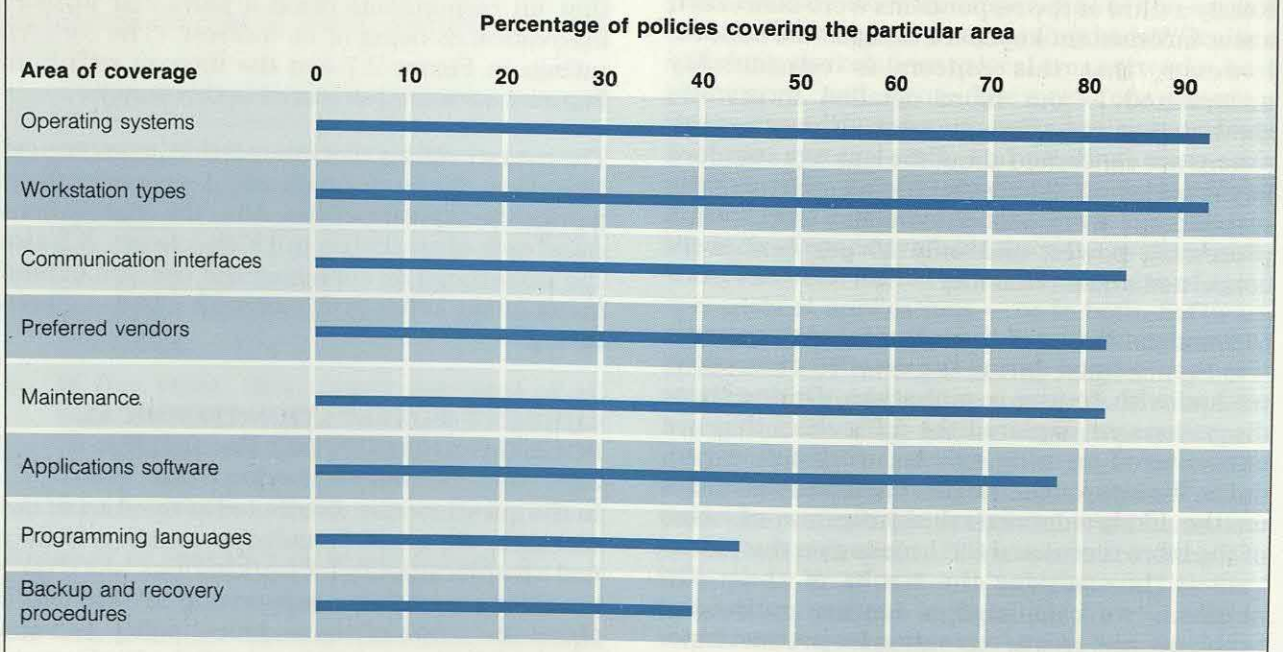
Figure A.7 shows the results of the questionnaire responses and, much to our surprise, reveals that 12 per cent of the organisations that responded have no technical policy for workstations. The main reason for this appears to be related to these organisations' charge-out policies for systems services. Where user departments pay the full costs for all their systems activities in 'real' money (so it affects the users' bottom line), there is usually a complementary policy that allows users to choose and buy their own workstations.

The scope of the technical policies for workstations is also shown in Figure A.7. The typical technical policy does, to some extent, reflect the changing role and importance of workstations, but it is also designed for the convenience of the systems department and to reinforce its traditional practices. Thus, on one hand, workstation programming languages and backup and recovery procedures are the least likely areas to be covered by existing technical policies (in 44 per cent and 40 per cent respectively of the policies in our survey). On the other hand, communications interfaces is one of the most likely areas to be covered (in 84 per cent of the policies). The fact that languages and backup procedures are not included in most technical policies demonstrates that most systems departments still perceive workstations as standalone devices where programs and data are personal, and users are expected to make their own backup arrangements. The high incidence of communications interfaces in the policies reflects the growing demand from users for linked workstations and the realisation that such linkages require an overall plan.

The low incidence of programming languages in technical policies may also be a reflection of the typical systems department's low opinion of new workstation-based development tools. In this respect, the technical policy complements the workstation support philosophy (see Figure A.8), with only 46 per cent of the organisations with a support unit providing programming support for workstation users. The attitude often seems to be that if workstations use nonconventional languages, their users can hardly expect *real* (that is, traditional Cobol) programmers to develop programs for them.

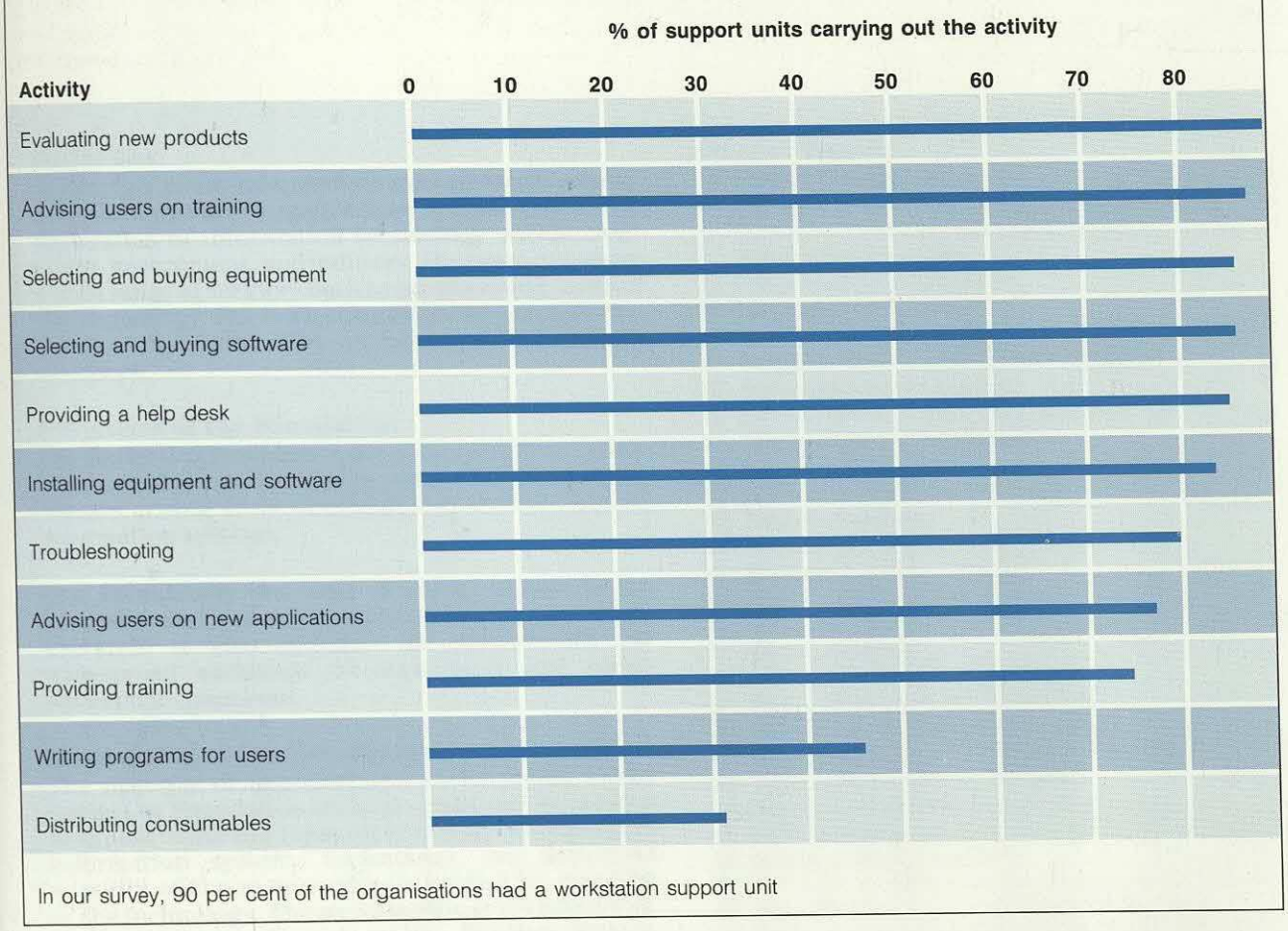
The technical policies mostly concentrate on physical rather than logical standards. Typically, the policy restricts the type of workstation (93 per cent of the policies in our survey) and the application software (78 per cent of the policies) that a workstation user can have and specifies from whom it should be bought. Thus, the emphasis is on restricting users to specific products and vendors, rather than on specifying the underlying architectures and standards

**Figure A.7 Content of technical policies for workstations**




In our survey, 88 per cent of organisations had a technical policy for workstations

**Figure A.8 Activities carried out by workstation support units**




In our survey, 90 per cent of the organisations had a workstation support unit

Again, the support philosophies reflect the technical policies. Systems staff are familiar with the tasks involved in evaluating new equipment and software. As a consequence, 89 per cent of the organisations providing support for workstation users include product evaluation as one of the activities, thereby complementing the technical policies that restrict the users' choice of equipment.

We were also surprised to find that about 10 per cent of the respondent organisations provide no formal support for their workstation users. Those that do provide support tend to concentrate on tactical support (equipment selection and purchase, for example) and operational support, such as providing a user help desk.

# BUTLER COX FOUNDATION

## Butler Cox

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

## Objectives of the Foundation

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

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

## Membership of the Foundation

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

## The Foundation research programme

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

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

## The report series

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

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20 The Interface Between People and Equipment
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22 Applications Packages
23 Communicating Terminals
24 Investment in Systems
25 System Development Methods
26 Trends in Voice Communication Systems
27 Developments in Videotex
28 User Experience with Data Networks
29 Implementing Office Systems
30 End-User Computing
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60 Expert Systems in Business
61 Competitive-Edge Applications: Myths and Reality
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Network Management
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Computer-Aided Software Engineering (CASE)
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## Availability of reports

Members of the Butler Cox Foundation receive three copies of each report upon publication; additional copies and copies of earlier reports may be purchased by members from Butler Cox.

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