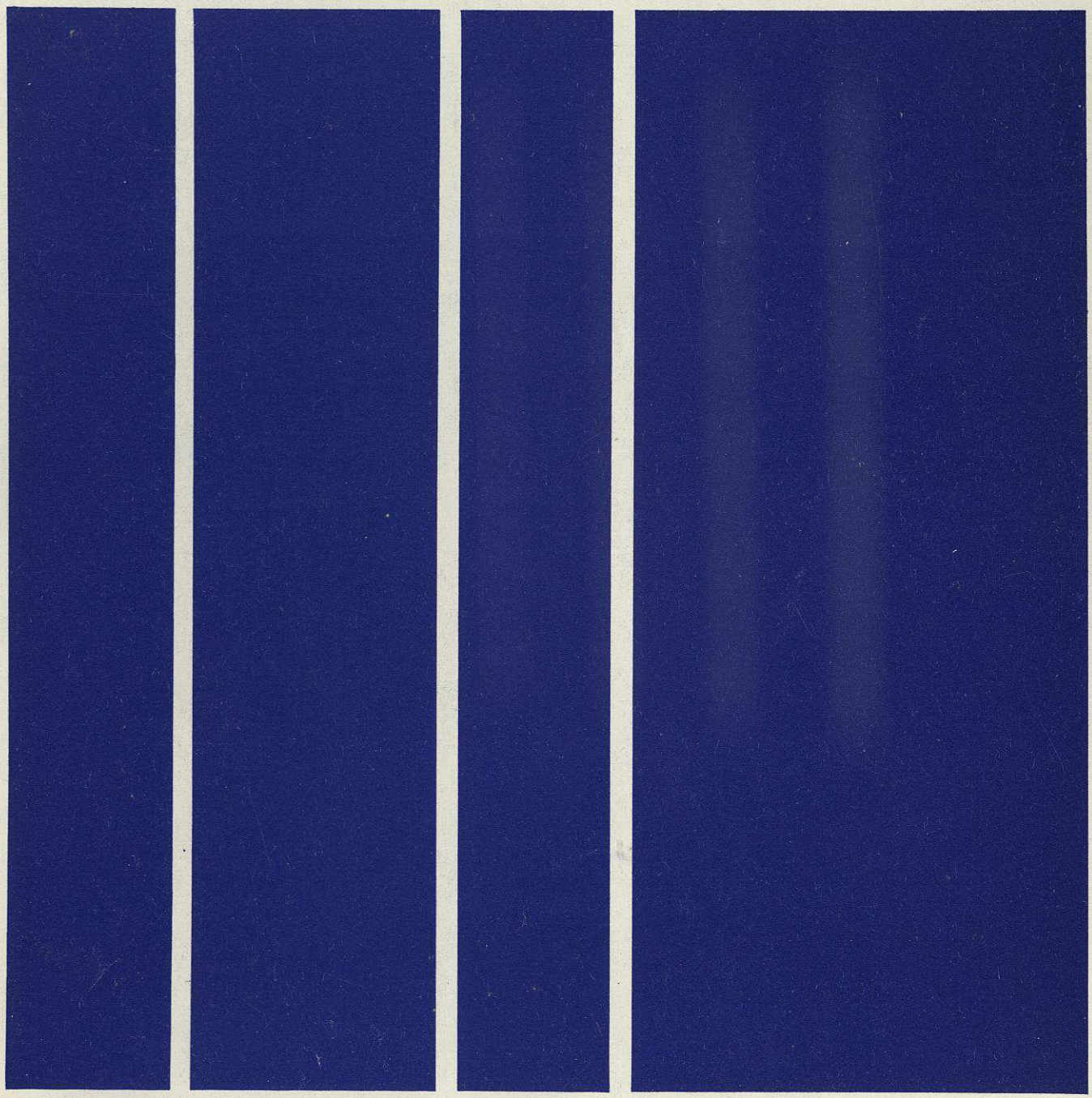
Report Series
No 2

Display Word Processors

August 1977



The Butler Cox Foundation

Report Series No 2

DISPLAY WORD PROCESSORS

AUGUST 1977

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TABLE OF CONTENTS

I. INTRODUCTION

A. Readership And Purpose

This report is for managers responsible for advising or authorising spending to improve office efficiency, including administrative managers, O & M specialists and staff from management services departments. Its aim is to help answer the question 'can our organisation make profitable use of display word processors?'

Word processing has attracted interest in recent years as managers have looked for ways to improve office efficiency. The newest products are computer-based display word processors, sometimes called display text editors. At first sight they hold great promise, but they are expensive and as yet few organisations have much experience of them. The technology is advancing rapidly. Should managers invest in this equipment now, or should they wait to see what developments will take place in the next year or two?

B. Background

Most organisations have discovered that their office costs have risen rapidly in recent years. Non-manual labour costs have roughly doubled since 1970. Paperwork volumes have grown some 4% p.a. over the past decade (though a lot of the increase is due to copying machines whose growth is now beginning to slow). Yet office labour productivity has remained relatively static — for example a growth of only 4% in the U.S. between 1960 and 1970, compared with 83% for manual workers over the same period.

The reasons for low office labour productivity include the nature of the equipment – generally a conglomeration of non-standard, stand-alone devices; and low equipment investment – the per capita value in the average U.K. office is under £500, compared with about £5,000 in manufacturing industry. (In the U.S. the figures are $2,000 and $24,000 respectively).

As a result most organisations have seen a considerable increase in the proportion of their staff engaged on administrative and clerical work: on average, from under 20% in 1950 to around 40% today. Just typing an A4 page today is likely to cost at least £3.

These cost trends are likely to continue, which explains why word processing is now a focus of attention as a possible aid to cost reduction. Word processing has a variety of definitions, though increasingly the term is becoming synonymous with automatic typewriters and their computer based derivatives. Perhaps in a few years from now it will refer simply to the latter, thus confirming the International Word Processing Association's definition:

'Word processing is the application of computer technology to the typing process'.

C. Report Scope And Structure

In this report we accept the above definition, but we restrict our attention mainly to display word processors because the field is growing rapidly and gaining a good deal of attention.

The subject can be divided into three main areas: equipment, office organisation, and economic justification. The main sections of the report follow this division, with separate emphasis given to developments in the future and to planning and installation.

We start in Section II with a brief review of typing applications in the office, and the suitability of automatic typewriters and display word processors for these applications. We distinguish between these two types of equipment, then raise a number of questions about display word processors to be answered in the following sections.

Section III is an analysis of the elements and features common to display word processors, and in Section IV we describe today's configurations, showing some details of a representative range of devices. In Section V we discuss their impact on people in the office. Section VI is a discussion of costs and benefits, and overall justification.

Section VII addresses likely developments in the next few years which will lead to much improved cost effectiveness. This forms a vital background to Section VIII which covers equipment selection and installation.

Organisations which do decide to invest now in word processing should recognise its role as the basis for developing office automation in the future. Besides satisfying themselves that the equipment can be justified in its own right, they should ensure that it can form a compatible basis for a later generation of equipment.

II. TYPING APPLICATIONS AND EQUIPMENT

A. Typing Applications

Exhibit 1 shows the range of typing applications in a typical office. Two of these applications — repetitive texts and revision typing — are clearly appropriate for typewriters having a text storage capability, so that re-keying can be reduced or even eliminated.

1. Repetitive texts

These consist of standard letters, programmed correspondence, information documents and the like:

- *Standard letters* are identical in all respects, except for date and address details. Examples include: mail shots, sales promotion letters, invitations and so on.
- *Programmed correspondence* is built up from a mix of standard sentences and paragraphs, with specific elements incorporated as well. Examples range from relatively simple credit control letters, responses to enquiries, quotations and thanks for services rendered, to complex policies and legal documents such as deeds.
- *Information documents* contain standard data which must be updated at intervals — for example price lists, catalogues, directories and registers.

2. Revision Typing

Revision typing is the retyping of sections of texts to accommodate amendments. These amendments can result from typists' errors, or more often from author's revisions to texts such as maintenance manuals, reports, standards, and technical papers.

The proportion of repetitive texts and revision typing clearly varies greatly between businesses, and departments within businesses. Nonetheless many businesses have found that the proportion of repetitive text in their total typing volume can be raised to 50% or even more. To achieve this they have created Correspondence Manuals often containing several hundred standard sentences and paragraphs whose maintenance and use require careful control and commitment.

Businesses such as legal offices producing lengthy documents with a high degree of paragraph standardisation have found that well over half their total text output can stem from repetitive text. Other businesses — such as consultancies — produce a high proportion of non-standard documents like reports which are subject to a number of re-drafting stages.

B. Automatic Typewriters

Automatic typewriters can store and retype text from a replaceable storage medium like paper tape or magnetic card.

The storage ability of automatic typewriters makes them appropriate for repetitive texts and revision typing. Indeed, most of their applications are to this kind of specialised work with emphasis given in Germany to the former, and in the U.S. to the latter. In addition, there are a few instances of automatic typewriters being used for the whole range of business correspondence. However, such applications are unusual because the overall productivity gain which can be achieved is lower than on the more specialised applications, and so installations are harder to justify.

Exhibit 1 Range of typing applications

repetitive text	standard letters programmed correspondence information documents
revision typing	long documents (> 5 pages)
other typing	internal correspondence external correspondence complex tables, charts etc.

Two well known examples of automatic typewriters are the IBM MC II and the Xerox 800 (about £5,000 – £7,000), but there are over thirty suppliers on the U.K. market offering a variety of models.

The replaceable storage medium can be paper tape, magnetic card, magnetic cassette tape, or magnetic disc. Each has its own merits and disadvantages in terms of storage capacity, access time, ease of handling and cost. Besides recording text, automatic typewriters provide some degree of assistance with text editing – depending largely on price, and including at least some of the following:

– backspace correction to erase and correct a character

– deletion by character, word, line, sentence

– insertion by character

– searching to and selecting designated text

– merging pre-recorded material.

In addition to text editing, there are text presentation facilities including:

– reformating with adjustable margins

– left and right margin justification

– automatic centering, underscoring, stored tabbing, and column alignment.

To justify their extra cost compared with regular typewriters, automatic typewriters need to be used intensively. Intensive typing areas can bring their own problems. Other difficulties with automatic typewriters have included prolonged training periods, lack of reliability, and difficulties with the organisation of and access to the libraries of stored text.

Against this background the relative lack of success of automatic typewriters is hardly surprising. The market base in the U.K. is only about 7,000 machines (60,000 in Europe), which is less than 2% of all installed typewriters.

C. Display Word Processors

Display word processors can be distinguished from automatic typewriters in that they use a display screen to decouple the keyboard from the printer. To emphasise the distinction, only devices with display screens of more than one line are considered in this report.

Using a display operators can get an immediate visual feedback and the opportunity to get the text right before committing it to paper. As a result, display word processors are easier to learn and to use than automatic typewriters. Combined with more powerful text handling logic and greater on-line file capacity in most cases than automatic typewriters, they can show an improved productivity on repetitive texts and revision typing. However, they are more expensive (about £8,000 – £15,000 per keyboard/display workstation), and whether their advantages are worthwhile is not immediately obvious.

The main attraction quoted by suppliers is that they can show a worthwhile productivity improvement over the whole range of normal office typing work, compared with regular typewriters.

However, a number of questions must be asked before that claim can be substantiated. These questions are to do with: the source of the productivity improvement; reliability; training; problems of display-induced eye strain; quality of printing and so on. And the problems of intensive typing lead to questions about their social acceptability. In the following sections we search for answers to these and other questions.

III. ELEMENTS AND FEATURES

All display word processors feature one or more of the following five elements: keyboard, display, storage, printer and logic/control. These elements can be configured in different ways and others may also be included. However those five are obligatory, and we begin this section with a review of each in turn. At the end of the section we examine some of the other elements and features which can be included.

A. Keyboard

Today's keyboards are all electronic with a standard QWERTY rectangular layout for the typewriter keys, and additional function keys.

1. Function keys

On some machines (e.g. Philips WP 5000) control commands are by dedicated function keys; on others (e.g. AES 100), commands are by combined function and typewriter key strokes using a simplified function keypad.

The former approach requires some twenty or thirty dedicated function keys, which means a larger keypad area and undesirable physical and psychological consequences. The latter can allow greater flexibility, but can be harder to learn, and usually entails more key depressions. Both approaches have their enthusiasts and there is little convincing evidence favouring one against the other at present.

The function keys include cursor control keys for cursor pointing on the display.

2. Typewriter keyboard

The main differences between machines are in key spacing, sculpture, sensitivity and positioning. Minor differences here can be important to typists — just as on regular electric typewriters.

A few machines (e.g. Wordwright) have programmable keyboards. These can be used for additional function commands or to address a glossary of terms.

B. Display

The most obvious differences in display design between the various models is in size. But there are also differences in features and presentation which are highly significant to typists.

1. Size

Display sizes range from a 'window' of a few lines up to a full page (displays of less than one line are excluded from this report). The display screens allow typists to check the current word for correctness, and also to check the whole page layout. With a full page display they can do this immediately; with a window display they can still do it, but not instantly, by scrolling the page under the window from a buffer.

Most screens are of the well-known CRT type, and the cost works out at very roughly 50p per character. So full page displays of say 6,000 characters are in the order of £2,000 more than common window displays of 1,920 characters. Views on the importance of display size are still in a state of flux, and there is little genuine evidence favouring conclusively any particular size.

2. Features

Displays differ significantly in the range of features they offer:

- Horizontal scrolling
  This can be useful for wide ('landscape') documents.

- Vertical scrolling
  This is usual on window displays to allow page viewing, but it can also allow 'fluid' searching of text beyond page boundaries on both full page and window displays.

- Text insertion
  This is usually by opening lines vertically on the screen, but an alternative is by horizontal rightward scrolling (e.g. IBM S/6).

- Status information
  This is in addition to the text display, usually on one or two dedicated lines at the head or foot of the display. The status display can include information such as:

  - tab/margin rack and page centre
  - current job identity, page and line number
  - cursor position
  - lines per page.

- Prompt information
  This is displayed in the same way as status information, with the aim of leading typists through their work and signalling invalid commands. The prompt does this by displaying simple questions for answering by the appropriate action. Some prompts are considerably more extensive than others: a valuable learning tool, but sometimes irksome to typists when they have achieved familiarity. Programmable prompts (e.g. Wordwright) help to overcome this difficulty.

- Highlighting
  Text areas identified for emboldening or for action (e.g. by pointing the cursor to a word, and selecting the sentence for deletion using the function keys) can be highlighted before execution in several ways. Three examples are: blinking underline, double brightness and reverse video (colour inversion).

- Special character features
  These range from underscore, sub and superscripts (e.g. for H_20,° C) and mathematical symbols, to semi graphic features such as boxing-in.

- Stored formats
  These are layouts which can be recalled from store to assist with tasks such as laying out letters in a house standard and preparing or updating tables of figures.

- Adjustable character spacing
  Some display screens can vary the character pitch (e.g. 10 or 12 to the inch, and even proportional spacing).

- Cursor control
  Most display word processors use conventional VDU-type keys for cursor control. One exception is Lexitron, which uses typewriter-like platen knobs and spacebar/backspace keys to simulate a regular typewriter. Again, most display word processors use cursors

which can move across the screen horizontally and vertically, and sometimes diagonally. With the IBM S/6 the cursor is moveable horizontally only – it stays on the fourth line, and the text must be scrolled vertically past the cursor to provide the second movement dimension.

– Type line entry
Most displays enter type lines from the top of the screen. One exception is Lexitron which shows type lines rising from the foot to simulate paper.

3. Screen fatigue

Many typists have reported problems of eye strain, headaches and fatigue after working with text displays – particularly when complex work involving considerable text manipulation or tabular work has demanded long periods of concentration on the screen.

What little research has been done in this field seems to indicate that the main factors involved are the screen position relative to the eye and the keyboard, and contrast glare. A third factor is the imaging of the characters on the screen.

– Screen position
Screens should be adjustable so that typists can position them for distance and angle relative to their eyes, and to the keyboard (typists prefer to look down at screens, not up at them). In practice there are no display word processors which completely meet these requirements. Indeed most have integral screens and keyboards with virtually no degree of freedom. A few (e.g. IBM S/6, Rotaprint Texxetta) have wandering keyboards with screens which can be tilted.

– Contrast glare
The average screen brightness should match the average brightness in the office in order to minimise the eyes' need to readapt with changing visual fields. This requires screens to have adjustable brightness (most do) and adjustable contrast (some do). It also favours a generally light background, with dark characters.

– Character imaging
Well imaged characters are much easier to read. The factors involved include

  – Character size: all display screens show characters that are larger than typed, but full page displays in general have smaller characters than window displays.

  – Character generation: on CRT screens, character generation is either by vector (e.g. Vydec) or dot matrix (e.g. Wordplex). In the latter case, usually the more dots the better.

  – Character shapes: these are fixed (i.e. independent of the print typestyle selected) and usually constrained by the needs to fit in a given dot matrix, or to allow for special character features such as underlines. Sometimes characters with tails, called ascenders and descenders (e.g. d, p), can be hard to read as a result.

Other factors include: character sharpness, steadiness, spacing and freedom from ghosting.

In general it seems to be the case that typists suffer more from screen fatigue when they are new to display word processors than when they are experienced with them, probably because they look into the screen more when they are gaining familiarity with the equipment.

C. Storage

To be effective storage must be low cost and easily accessible. Cost includes the drive as well as the exchangeable medium. Accessibility includes finding and loading the right off-line file as well as access time once the file is mounted.

Exchangeable storage media are all magnetic now. Floppy discs are used widely, with rigid discs restricted to the larger systems. Cassette tapes – widely used on automatic typewriters – are rare; magnetic cards are unlikely to see much use except as a bridge from automatic typewriters including the IBM MC II.

1. Floppy discs

The standard IBM single sided floppy disc (diskette) has a capacity of 1.9 million data bits, or 243K characters, using the 3740 format. Soft sectoring can raise this capacity about 20%. Alternatively, double density floppy discs are becoming available, and so are double sided floppy discs at both single and double density. The latter gives a capacity of 1.6 M bytes of unformatted data.

2. Rigid discs

Normal density cartridge discs have a capacity of about 2.5 M bytes.

Exhibit 2 shows approximate costs for floppy and rigid discs for text held both off-line and on-line.

- A filing cabinet can hold about 2,000 typed A4 pages at a cost of say £5 p.a. i.e. ¼ pence per page. The equivalent cost of off-line disc storage (with a roughly equivalent access time) is in the order of 10p per page for floppy disc, 6p for cartridge disc. On-line, these storage costs rise about thirty-fold.

- Large disc storage devices can bring these on-line storage costs down by a factor of about ten.

3. File management

The file management facilities provided on a display word processor are important because they play a major part in determining the ease with which a specified text area can be accessed, and the ease with which multipage documents can be handled as a text continuum rather than as a series of separate pages.

Most systems use a unique document number such as author name and date to identify each job, and most maintain a directory of job numbers. Typists wishing to retrieve a specific document can display the directory, and then call for the document itself to be displayed. To find a specific entry point say on a multi-page document they can either search visually page by page, or use a 'string search' to a specified mask. An alternative is to use a hierarchy of numbers – assigned either by the typists or automatically – to identify blocks of text down to the paragraph or line level. This approach requires the searching typist to know the specific text block number required – which means sight of a printed draft with the numbers on it.

In general, floppy discs are organised with one line of text per sector and one page per track. The arrangements for sector (line) overflow, track (page) overflow and track linking in multi-page documents vary, but most floppy disc systems are page oriented and typists need to work a page at a time. For example after inserting a block of text on the first page of a multi-page document, they have to instruct the system to re-make up the following pages by successive page-get and make-up instructions.

Exhibit 2 Comparative Storage Costs

	floppy discs	cartridge disc
cost per drive £ purchase	500	4000
£ p.a.	170	1300
cost per disc £ purchase	6	75
£ p.a.	6	40
capacity in M bytes	.25	2.5
in pages of 4K char.	60	625
off-line cost p/page p.a.	10	6
on-line cost p/page p.a.	290	210

Compared with most floppy disc systems, rigid discs offer more flexible file management, giving full text-orientation – i.e. the ability automatically to adjust following pages after an insertion on the first page of a multi-page document.

4. Number of drives

Most display word processors can have more than one drive spindle. Multiple drives cost more, but confer greater flexibility than just one; file merging is faster, and file security is easier. Also, on-line file capacity is increased. Multiple drive spindles are useful, but not essential.

D. Printer

All word processors must be able to produce correspondence quality printed output, equivalent to a good electric typewriter. To meet this need nearly all use high quality character (serial) impact printers though IBM's recently announced 6640 non-impact inkjet printer is an exception. A secondary need is for draft quality printing, and a third is for typeset quality.

1. Typewriter quality impact printers

On display word processors exchangeable single element printers have displaced the basket design familiar on older typewriters. The best known single element is probably still the IBM golfball, but recently the single element petal design has become very popular mainly because it is faster (up to 55 characters per second compared with about 15).

Petal print wheels are supplied by Diablo, Qume and others in a variety of popular typefaces. Most have 96 characters, one to a spoke, though one recent design uses 2 characters each on half the number of spokes in an attempt to improve the wheel life. Usually there is one print wheel per printer, but some models offer two print wheels to improve speed or to double the number of characters available (e.g. for special mathematical characters).

Most petal print wheels are available at 10 or 12 pitch. However, the printer drive mechanisms are able to space the characters horizontally at less than one hundredth of an inch. This can allow emboldening by retyping with an offset; right margin justification by adjusting the space between words and also between characters within words; and proportional character spacing – though the current shortage of print wheels with proportional characters is constraining the use of this feature.

Print wheels with popular typestyles cost around £7 each and need replacing every month or so (improving materials technology will undoubtedly lead to longer life in future). Ribbons cost about £1.50 each and they last for about 2,000 lines, which can mean replacing them daily.

2. Typewriter quality non-impact printers

Recently more research has gone into non-impact printing than into impact printing because it promises higher speeds, lower costs, greater reliability, less noise generation and programmable typestyles. IBM's inkjet printer will be the first of many new designs. The quality of this device is not quite yet up to the standard of character impact printing, but spray dot resolution is improving continuously in the laboratories, and we have no doubt that the quality will be equivalent within a year or two. The disadvantage of top-copy-only will remain, but can be overcome by electrostatic copying. The current speed of the IBM inkjet printer is 92 characters/second.

3. Draft printers

Draft printers include matrix printers, and various types of line printer. They are usually available on shared logic systems but not on stand-alone devices. Their purpose is to produce draft quality printed output quickly when correction is virtually certain to be necessary – as on lengthy research reports for example. Compared with character printers they only show a

speed and price advantage if they are well utilised. Their print quality is improving rapidly, and may soon be equivalent to character printers.

4. Typeset quality printing

By linking a word processor to a phototypesetter, typeset quality printing can be produced without having to re-key the text. The link can be made as yet on only a limited number of word processors, by media interchange or over the telephone lines (given the right protocols). The necessary control codes for the particular phototypesetter to be used can either be supplied through the word processor keyboard or at the phototypesetter keyboard.

Businesses of all sorts use typeset quality printing for a variety of documents such as brochures, catalogues and price lists. Compared with typed printing, typeset work looks better and uses less paper because of:

- The wide range of typestyles and point sizes available. A typical phototypesetter has 4 typestyles on-line (exchangeable film masters ready for automatic selection in the turret) and about a dozen type sizes (say point sizes 5 to 72).

- Proportional spacing, typically with about 13 different character widths (about three times more than proportional spacing typewriters).

- Graphic quality character impressions. On a phototypesetter these are generated from film or digitally stored masters which are displayed on a CRT and then reduced.

Other advantages include superior indexing control – for example to set a 9 point size onto a 10 point body.

Because the typographic qualities of printers cannot be simulated accurately on display screens, all display word processors involve some degree of re-formatting on output. For example, right margin justification is nearly always performed on output, not on the display. On some models, text can be manipulated optionally without the results having to be displayed. The advantage is that typists do not have to wait for display responses, but the penalty is that they forego a visual check. Storing the commands allows the text to be formatted entirely on output.

By our definition, display word processors can support background printing simultaneously with foreground keyboard and display operation. At 50 characters per second a petal printer is about ten times as fast as a typist's drafting speed, and it is unusual for a typist to be kept waiting for the printer.

Other important considerations besides printing quality and speed include:

- Paper handling
  With a printer dedicated to a typist at a single keyboard/display, paper handling can be a problem because the printer is both out of phase with the keyboard, and accessible only by reaching. The solution of using continuous forms is not satisfactory when a variety of different stationery has to be used (letter heads, internal memos, plain paper etc.) and it is expensive. The alternative of hopper feeding is neither reliable yet nor widely available.

  With shared printers dedicated staff can relieve the typists of the problem of paper handling, though this solution requires some sophistication in print queue control and organisation.

- Maximum form width
  The maximum form width and characters per line on petal printers is usually about the same as on standard electric typewriters.

E. Text Handling Logic And Control

Text handling embraces text editing and presentation. Text editing includes the insertion, deletion, amendment and selection of text. Facilities for the presentation of this text are often included under the heading of text editing because they are defined during the same keyboard operation. More strictly they should be kept separate.

1. Text editing

Display word processors usually incorporate these features:

- Correction by backspace and overstrike
- Insert, delete, move: character, word, sentence, paragraph, section, column.
- Search to, delete, replace: a string (mask) of defined characters.

Restrictions demanded by different word processors are mainly about the extent of text editing . . . . e.g.:

- Limits on the size of text blocks which can be moved
- Limits on searching beyond page boundaries (global search)
- Limits on text movements over page boundaries

. . . and how to achieve it, e.g.:

- Defining text blocks using a numbering system, or by cursor pointing
- Moving by a direct move function or by store/recall (i.e. save/get).

There is an inevitable trade off between capability, cost and ease of operation.

2. Text presentation

Display word processors usually incorporate most of these features:

- Stored tabbing
- Line length control, with automatic word wrap around onto the next line; sometimes an adjustable right hand hot zone for soft (discretionary) hyphenation is included
- Adjustable margins, so that text can be automatically reset within redefined margins
- Right hand margin justification
- Line count to control overflow onto a new page
- Pagination (page numbering)
- Optional centering of text e.g. headings
- Running heads
- Indexing to allow small vertical movements — increments and decrements — for superscripts such as in ^{o}C or $H_2 0$, or with language accents

– Columnar alignment including decimal tabulation (numbers automatically aligned on the decimal point)

– Paragraphing (vertical space and indent)

– References and footnotes formatted automatically

– Movement of references and footnotes with associated text

– Underscoring and/or emboldening within defined areas of text.

As for text editing, there can be a significant difference in how these functions are achieved. One example is in right hand margin justification; to achieve the fixed line length, the inter word gaps alone might be adjusted, or the character pitch in the words might be adjusted as well. Spacing increments might be shared out proportionally along the whole line, or in fixed increments from one of the margins just as far along the line as necessary.

The system control can be through one or other – or a combination – of the following:

– Microprocessor, for example an Intel 8080 chip either hard wired (ROM) or soft (software held in a RAM store)

– Minicomputer

– Mainframe

Hard machines are becoming more capable as micrologic gains power, and the logic chips are exchangeable to allow enhancements. Soft machines require a software loading operation, and they present the risks of maintenance and bugs. However, soft machines offer greater flexibility, and the opportunity for customisation.

F. Other Features

Other features are available in addition to those described above, including communications, OCR and COM.

1. Communications

The aim is to allow word processors to communicate with each other and/or mainframes. In practice, communications interfaces are not yet available on all the market offerings, and their use is generally restricted to other models of the same kind. At present there is little evidence of even this in the U.K., but in the U.S. a number of organisations are experimenting to assess the potential benefits.

At a different level, some word processors can be used to prepare Telex-compatible tapes (we do not know of any which can replace a Telex machine).

2. OCR

Attaching an OCR reader can allow ready-typed text in an OCR-readable font to be processed by a display word processor in the normal way without it having to be re-keyed.

This can be a valuable aid for internal text file conversion, and for incoming mail. Another purpose is for text creation: draft text can be typed on regular electric typewriters, then read through the OCR reader into a display word processor for layout and error amendment, storage and final printing.

3. COM

By outputting COM, a word processor can be integrated into a company's microfilm storage and retrieval system. In the long term, with very cheap on-line digital storage, COM is likely to become a back-water. But because of existing investments in COM systems, this approach will be attractive to some businesses. It is even possible that microfilm search and display techniques will be integrated into some word processing displays.

IV. CONFIGURATING THE ELEMENTS

The five main elements described in the previous section can be configured in three distinct ways: stand-alone, shared logic and mainframe (see Exhibit 3). Each has its own advantages and disadvantages.

1. **Stand-alone devices**
   These contain the elements in a compact desk-sized unit. The main features and prices of a representative selection are shown in Exhibit 4.

2. **Shared logic systems**
   In these systems a number of keyboard/display work stations can be connected to shared storage, logic and control, and printers via high speed local cables. Exhibit 4 shows similar details as for stand-alone devices.

3. **Mainframe systems**
   Here one or more work stations can be connected either locally or remotely to a shared mainframe with word processing software and peripherals. These are available for mainframes from most of the large manufacturers; IBM's ATMS is probably the most widely used software package.

Above about five keyboard/display work stations, the price per station of a shared logic system is competitive with the equivalent number of stand-alone devices. On minicomputer based systems such as Unicom and Wordplex 7 at least twelve work stations can be attached before there is obvious degradation of response times.

Compared with stand-alone devices, shared logic systems have the advantages of greater on-line file capacity shareable amongst the typists, and more powerful text handling logic. Other advantages include work stations which are more compact than desk units, and superior file and paper handling facilities.

On the other hand, stand-alone devices can be acquired a single unit at a time so the initial commitment is lower. Their positioning is more flexible; work stations on shared logic systems generally have to be placed within about 1000m of the logic/control unit. Also they avoid the risk of a total breakdown which is inherent with shared logic systems.

A recent trend is for suppliers to offer stand-alone devices compatible with shared logic systems, to provide a natural growth path.

Mainframe systems are designed to run concurrently with ADP applications. At first sight they are attractive to organisations with sufficient spare mainframe capacity to add on the required number of keyboard/display work stations, printers and probably storage devices as well. One disadvantage is that in general the available software provides text editing and typographic facilities which are less complete than on the dedicated systems. Another disadvantage — at least to many office administrators — is the involvement with and dependence on ADP; we discuss this problem in Section V D.

However, the mainframe approach can offer the valuable benefit of shared data bases. This is very significant to organisations with word processing applications which require data input from ADP files; examples of this are spare parts lists and engineering maintenance manuals. We

Exhibit 3 Configurating the elements

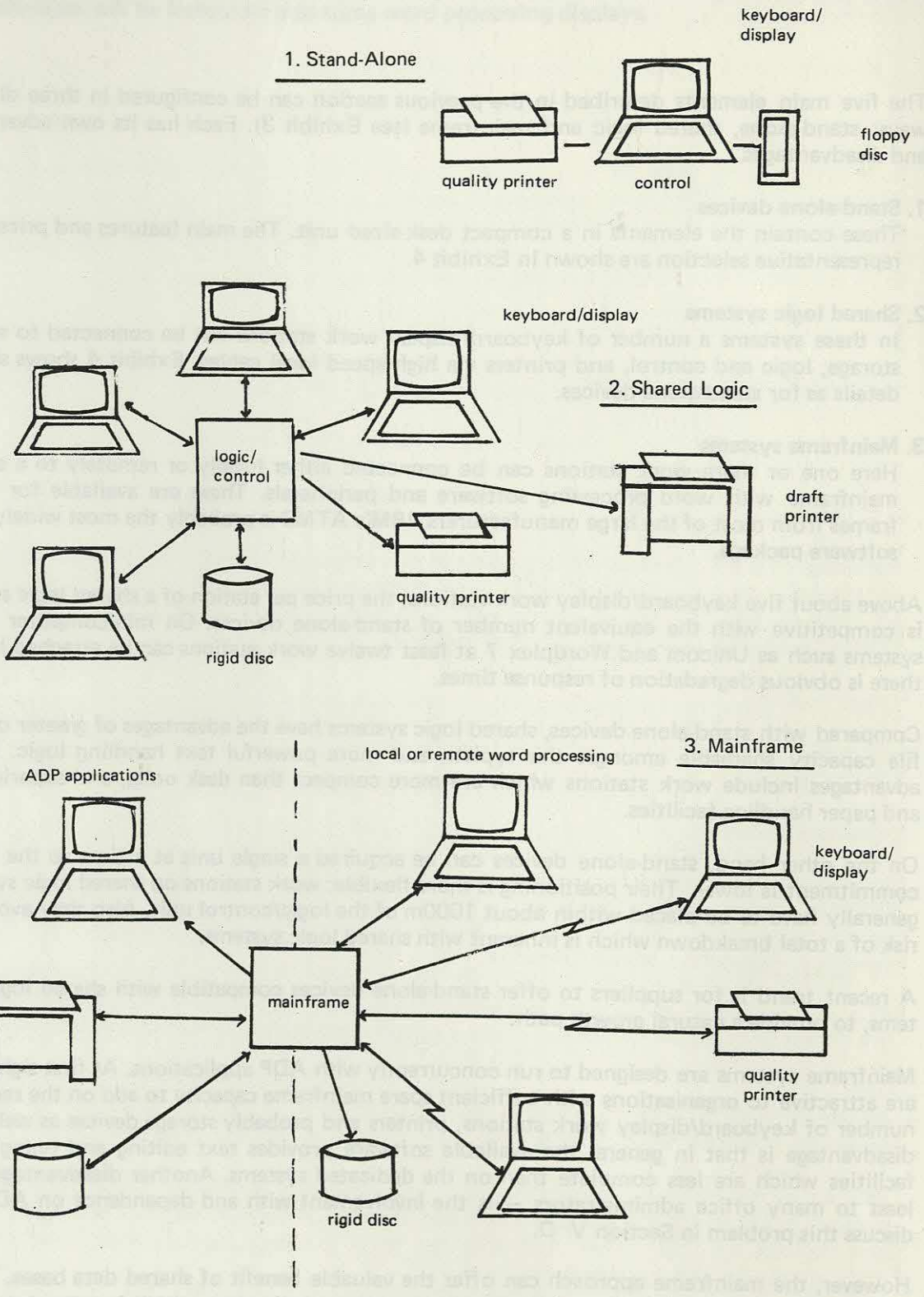


Exhibit 4 Key features of some current devices: Stand - Alone

make	model	display lines x ch/line	storage	printer	directory/ search	unusual features/comments	commⁿ interface	composⁿ interface	£ price and comments
AES	100	24 x 80 incl.status & prompt 7 x 12 dot matrix (green on black)	single/dual floppy	Qume, 45 cps. 10/12 pitch	directory, then visual	auto index update	optional	no	£8650 for single disc £9550 for dual disc
Data Recall	Diamond	22 x 80 no status or prompt (black on grey)	up to 4 floppy	Diablo or Qume 10/12 pitch	directory, then visual	fwd.vert.scroll only	yes	no	£7880 for dual disc £350 for calc.pckg.
IBM	S/6	8 x 80 incl. 1 line status, 1 line prompt (green on grey)	mag.card & floppy	15 cps or shared inkjet at 92 cps.	directory, then index or string	status and prompt, resident training, format storage	optional	no	£12000 for 6/430 (without printer), up to £23000 for 6/450 with inkjet
Lexitron	Video-type 942	66 x 122 (=8052) vector (green on black)	single/dual high speed cassette	Diablo, 45 cps. 10/12 pitch	directory, then visual	platen scrolling	optional	no	£13000 for dual cassette
Ontel	Word	24 x 80 13 x 11 dot matrix black on white + reverse	dual floppy	Diablo, 45 cps. 10/12 pitch	directory +	2 status lines	optional	no	£8500
Philips	WP 5000	24 x 87/100 (shows 10/12 pitch) 7 x 11 dot, green on black	mag. card (IBM compt.)/ single/dual floppy	Qume, 45 cps. 10/12 pitch	string search	status and prompt	no	no	c £10000 for dual floppy
Redac-tron	Redactor II	59 x 84 (=4956), magnify mode & 10/12 propⁿ pitch	dual cassette	Qume, 55 cps. 10/12 propⁿ spacing or 222 lines/min.	directory, then index or string	status and prompt, magnify mode	no	no	£9500 with dual cassettes
Vydec	Editor 1400	64 x 96 (from a 4093 char.memory) green on black	dual floppy (4093 char/page)	Qume, 10/12	no directory then manual track search	format storage	optional	no	£10850
Wang	10A	24 x 80 green on black	dual floppy	Diablo, 10/12	directory, and string search	2 line status and prompt, glossary	optional	yes	£9000
Wordplex	1	24 x 80 7 x 9 dot matrix green on grey	dual floppy	Diablo, 45 cps.	directory, and string search	hardware/software compatible with Wordplex 7	yes	no	£8500

Exhibit 4 cont. Key features of some current devices: Shared Logic

make	model	display	storage	printer	directory/ search	features/comments	comm^{n} interface	compos^{n} interface	£ price and comments
Monotype	96	20 x 96 7 x 9 dot matrix black on white	Single floppy/station with inter stn. sharing Optional shared cartridge disc.	Shared Qume 45 cps, shared line printer optional	directory, then string search	print scheduling; other pckgs (e.g. VAT, invoicing) being prepared	yes	yes	£10000 basic + £3200/work station (up to 3)
Rota-print	Texxetta	24 x 80 full status/prompt white on black	up to 4 floppies/ station, dedicated or shared	Diablo, dedicated or shared; optional shared high speed printer	directory, then string search	'gap filling' with various type fonts	yes	yes	£27500 for 4 work stations and 1 printer. (up to 8)
Unicom	VTS	24 x 80 green on grey	up to 4 cartridge discs: total 10Mb	various, shared	directory, then string search	print scheduling, format storage	yes	yes	c £60000 for 8 work stations and 2 printers
Wordplex	7	24 x 80 5 x 7 dot matrix (not as W'plex 1) no sideways scroll	min: 2 x 40 Mb max: 4 x 80 Mb	various, dedicated or shared	directory, then string	print scheduling, W'plex connectable	yes	yes	c £60000 for 8 work stations
Word-Wright		21 x 80 standard (green or grey) or 21 x 80 semi-graphic (black on white, reversible).	cartridge discs and archival mag. tape	various	4 level index to line, or string search	bureau, or independent shared logic system; designed for long texts and composition interface	yes	yes	from c £8000/work station with bureau; or from £35000 per 4 station dedicated shared logic system

anticipate that there will be a growing need for shared ADP and text data bases in the future. However, in our judgment it will not be achieved by developments of today's mainframe systems, but rather by developments of today's dedicated word processing devices which will communicate with mainframe data bases as required for specific applications (see Section VII).

One other approach to display word processing is via a timesharing bureau service – either dedicated (e.g. Wordwright, the only one of this sort in the U.K. at present) or as an extension to the range of services provided by a normal timesharing bureau (i.e. a mainframe system). The main attraction is the opportunity to gain experience without the level of commitment which would otherwise be entailed. The Wordwright service offers powerful text-orientation and photosetting interfaces, and there is a growth path into a dedicated shared logic system.

V. THE IMPACT ON OFFICE ORGANISATION

Display word processors need to be used intensively to justify their extra cost. Perhaps the most obvious way to achieve this is by centralisation, which means either establishing a centralised typing service, or perpetuating one which already exists equipped with regular typewriters and/or automatics. However, display work stations can be decentralised and still used intensively, and for some this alternative will have attractions.

Besides the issue of organising for intensive use, we discuss the question of typists' acceptance of the equipment itself in this section, and also the involvement of ADP.

A. Centralised Typing

Recent surveys (e.g. SRI 1976) have shown that average personal secretaries spend about 25% of their time at the typewriter keyboard, and the remainder on an assortment of administrative duties punctuated with spells of waiting. Many businesses have tried to improve their secretarial efficiency by dividing the function into two distinct specialisations, typing and administration. They have created centralised typing production services staffed by correspondence secretaries and concentrated on improving efficiency by attention to dictating equipment, work flow and improved supervision. At the same time, they have created specialist administrative services with groups of administrative secretaries servicing a number of principals.

Often the results have been favourable. Correspondence secretaries have been able to produce many more lines per day than before, and groups of two or three administrative secretaries have been able to service eight or more principals. Overall, these businesses have been able to make worthwhile savings in secretarial staff, and some have reported other benefits as well including better typing quality, improved support for principals and lower staff turnover.

In most of the instances where there have been significant improvements in typing productivity, the gain has not been attributable to a change in typing equipment. Having said this, a number of businesses with successful centralised typing areas have made further gains in productivity by exchanging at least some of their regular electric typewriters for automatics.

However, there have been examples of businesses switching to specialised secretarial functions only to encounter a variety of problems, some so grave that the move to centralisation has had to be abandoned. These problems have been essentially human ones for the principals, for the administrative secretaries and for the correspondence secretaries.

1. Problems for principals

These problems – either real or imaginary – can include:

- Loss of status
- Lack of faith in the production area, either to produce the output or to maintain security
- Loss of personal service both in typing and in administrative services
- Reluctance to use dictation equipment: non-dictators are often penalised by production typing areas (e.g. by getting low priority) yet most managers are both untrained and reluctant to use them

– Difficulty of delegating to shared administrative secretaries, with consequential lack of support.

When both typing and administrative secretarial services have been good, principals find it hard to complain. Some principals even prefer the centralised approach – not only because the service can be better, but because they are relieved of the onerous task of delegating to and administering a personal secretary.

2. Problems for administrative secretaries

Administrative secretaries have often found that:

– They are under utilised. This is a common complaint, though it is hard to understand in view of the fact that the average personal secretary is mainly involved with non-typing duties such as filing, copying, telephone calls, diary maintenance and travel arrangements

– Their relationships with correspondence secretaries are awkward

– They lack genuine career development opportunities, often over-sold in the first place.

These problems are not easy to overcome. Companies which have succeeded have:

– Chosen the right administrative staff (flexible, mature), trained them well and supervised them carefully

– Located them close to their principals and supported them with the appropriate telephone system, copying and filing equipment

– Provided them with a career path (now independent of their principals) into executive or senior secretarial roles.

3. Problems for correspondence secretaries

Many correspondence secretaries have experienced:

– A feeling of remoteness and lack of identity with the principals and other word originators

– Their variety of work replaced by concentrated drudgery.

However, there are also satisfactions to be gained:

– In the quality and volume of work achieved in a generally busy atmosphere

– In friendships established, and the satisfaction of working as part of a team

– In career opportunities into supervisory positions.

Most ADP managers are already familiar with these problems and satisfactions through their experiences with centralised key punch and verify departments. Successful managers of centralised typing areas have learnt that their problems can often be overcome by:

– Choosing the right supervisor who can become an acceptable leader figure

– Paying careful attention to training, equipment and the working environment

– Ensuring a maximum work variety by rotating different work types and sources

– Choosing the right correspondence secretaries having strengths which include thorough-

ness and application, but who tend not to be outgoing

– Establishing a clearly defined procedure covering items such as booking-in, priorities and work rotation.

B. Decentralised Intensive Typing

We have seen that by creating specialist secretarial services typing productivity can be improved without necessarily changing from regular typewriters to more sophisticated devices. Organisations that have centralised successfully are already reaping the benefits, and many are now considering whether the further productivity potential of intensively used display word processors can be justified.

Can organisations use display word processors intensively when they are decentralised – either because they are unwilling to risk the human problems of centralisation, or because they want to revert from a centralised organisation?

One alternative is to distribute the correspondence secretaries so that they are part of a logical pool rather than a physical one, either using shared logic work stations, mainframe terminals or stand-alone devices. Performance monitoring can be through the work station with supervision still centralised. A variation on this is the idea of establishing clusters each of two or three specialised administrative secretaries and one or perhaps two typing stations, providing secretarial assistance for a number of local principals. It has the merit of destroying the pool stigma whilst retaining most of the benefits of the intensive, centralised approach.

Another alternative is for each work station to be shared amongst a small group of personal secretaries. This approach requires sharing arrangements to be agreed without incurring undue problems of priority, and sufficient volume of work to keep each work station loaded. These are difficult conditions to meet in practice and we are not aware of a successful application using this concept. However, the undoubted advantage is that organisational changes can be minimised.

C. Typists' Response To The Equipment

Typists respond in different ways to the display word processing equipment itself, just as they do to the pressures for intensive use described above.

Nearly always they enjoy being involved with a focus of attention, and mastering a new technology. On the other hand, the nature of the equipment can provoke unfavourable reactions:

– Incomprehension of the equipment's complexities, usually through inadequate training

– Frustration at breakdowns

– Eye strain and other fatigue problems.

The typists' perception of the equipment is not as a computer terminal with its attendant intellectual challenge, but as a text production aid. Can it really help with layout? How complex are the functions? How easy is it to perform the housekeeping, to create and recall files, to delete files when they are no longer required? How easy is it to change paper size and shape? Is it foolproof – can the screen content be lost, or stored text deleted by accident?

Display word processors demand skills different from regular typewriters. The traditional keyboarding skill is at a lower premium because factors such as line length and error correction are easier to control. On the other hand, new skills are needed instead: there is more emphasis on using multi-function keys and codes, on work organisation and file management.

However, the extent of the need for these new skills depends on a host of factors such as the keyboard layout, the keystroke combinations required to execute text handling, and the provisions for paper handling and file management. In some shared logic systems these last two can be made easier from the typists' point of view than with stand-alone devices, because they are both performed by specialists.

Typists vary widely in skill and temperament, from the career motivated senior secretary to the temporary. As a result their requirements for aids and features in display word processors also differ. For example, display screens which simulate paper are welcomed by some but not by others. Simple prompts are universally welcomed as a valuable aid to learning but some typists find prompts which cannot be disabled after the learning period to be a hindrance.

Most typists with experience of both display word processors and automatic typewriters agree that the former are easier to learn to use – often considerably easier. Of paramount importance is the need for simple, fatigue-free operation.

D. The Role Of ADP

Most organisations with stand-alone or shared logic systems have installed them without the advice or assistance of the ADP department – though sometimes management services' consultants or O & M staff (not part of the ADP budget) have been involved.

Administration managers seem reluctant to involve ADP: perhaps because they do not see the need, perhaps because they feel this can only bring interference and delay. This is a pity because the analysis of requirements, selection of equipment and implementation of change are precisely the skills that ADP have acquired over the years.

At the same time, many ADP departments seem surprisingly reticent about getting involved, perhaps feeling that office equipment is below their level of interest. This would appear to be a shortsighted view, considering the likely future patterns of systems integration.

On the other hand, ADP has always been involved when organisations have developed their computer word processing using terminals connected to the in-house mainframe, or to a time sharing service bureau. In these cases, ADP has been involved with cost justification, equipment selection and priority conflicts. They see their involvement continuing in the future, often with word processing and ADP converging as a result of shared data bases.

VI. ECONOMIC JUSTIFICATION

Most managers will want to be assured that display word processors can pay back their investment in an acceptable period before considering their acquisition. In this section we examine their extra costs and benefits compared with regular typewriters, then discuss their justification.

A. Costs

Prospective users of display word processors can quantify their extra costs with reasonable accuracy. The following is a guideline:

- Equipment Purchase Price
  Using the prices given in Exhibit 4 as a guide, we assume the extra cost of one work station to be £9,000. Terms for rental and lease vary widely, so we use the purchase price (cost to the user) for simplicity.

- Maintenance and Insurance
  This is a recurring charge which averages about 15% of the purchase cost per annum.

- Consumables
  This includes paper, ribbons, print wheels and storage. We assume the extra cost of the first three of these to be some £400 p.a. per work station; and the cost of storage to be equivalent to one floppy disc per week i.e. about £300 p.a. Overall this is equivalent to some 8% of the equipment purchase price per annum.

- Supervision and Training
  This will vary widely between applications. We assume the extra cost to be equivalent to 30% of staff employment cost – about £1,200 p.a.

Other costs, which are very hard to quantify, can result from organisation changes consequential to the use of display word processors as described in Section V.

B. Measurable Benefits

We distinguish measurable benefits from those that are very hard to measure, which we discuss in C below.

Measurable benefits are those that arise from improved typists' productivity. There are four contributors to this improvement: captured keystrokes, faster error correction, typing at drafting speed and quicker laying out.

1. Captured keystrokes
These are keystrokes already made, stored and available for use. The benefit depends on the proportion of time that the typist would otherwise spend re-keying, either as a result of typing errors (which would lead, for example, to a page being re-typed), or major author changes (such as in a heavily edited long document).

2. Faster error correction
These are 'conscious' character and word errors, which typists usually correct with a lift off

ribbon or paint as they go along on a regular typewriter. Using a display word processor they can backspace and overstrike in less time, raising their output some 10% – 15%.

3. **Typing at drafting speed**
   Typists with a regular typewriter usually copy type at well below their drafting speed to reduce the incidence of errors and to allow for line and page endings. Display word processors allow typists to type at nearer drafting speed, at some 20% – 30% more keystrokes per minute.

4. **Quicker laying out**
   Laying out ranges from address and salutation positioning, paragraph starts and margin positioning, through to complex table layouts which can be stored as formats on display word processors. The resulting time saving compared with regular typewriters is usually not less than about 5% for simple correspondence, and it can be higher than 100% for complex tables.

In Exhibit 5 we show comparative productivity improvements which can be expected for a range of different work types from the four contributors described above, and the figures emphasise the significance of work type. The exhibit shows the productivity improvement (x 240%) which can be expected from an 'average work mix' based on over 100 offices surveyed recently in the U.S.

However these benefits have to be brought at the expense of new penalties: screen induced fatigue, extra keystrokes for control, housekeeping, file and printer management, and time loss from equipment breakdowns. Overall, the extent of the benefit will depend primarily on the type of work involved.

In practice, typists' reported improvement in productivity varies widely in terms of lines per day – as is to be expected. In Exhibit 6 we show the lines per day output which can be expected as a result of four levels of productivity improvement. One of these – 210% – is a 'fair expectation' which is based on 240% for the average work mix but allows for the penalties mentioned above.

The improved typist productivity can be sought either to increase output from the existing staff, or to achieve the existing output from reduced staff.

In the first case, the value of the productivity improvement – assuming it is genuinely needed – is related to the cost of the alternative of employing extra typists including salary and employment costs, and possibly also a provision for supervision and floor space. In some cases an allowance is necessary to account for the fact that typists with the necessary skills are simply not available.

In the second case, the value of the productivity improvement is related to the savings in typists' salary and employment costs. This assumes that the displaced typists can be used effectively elsewhere in the business or wasted naturally.

To calculate a payback we will assume the benefit value of improved productivity on the basis of £4,000 p.a. per typist which is typical for direct salary and employment costs in the London area.

C. Hard-to-measure Benefits

These are benefits which are hard to quantify but which nevertheless can be very real and very important – depending on the priorities of the organisation.

Exhibit 5: Typing productivity gains from different types of work: display word processors cf. regular typewriters

work type		contributors to productivity gain: captured keystrokes	faster error correction	faster typing	quicker layout	productivity gain	comments on productivity gain	proportion of work type in avg* work mix %	new proportion of time %
repetitive text	standard letters	✓		✓		x5	in comparison with individually typed (not duplicated) letters	25	5.0
	programmed correspondence	✓	✓	✓		x3.5	assumes about 80% of each letter to be standard	8	2.3
revision typing	long documents (5 pages)	✓	✓	✓	✓	x2.5	assumes 2 drafts and 1 final with 20% text revision at each stage	30	12.0
other typing	internal correspondence		✓	✓	✓	x1.6	these are 1-2 page letters, the productivity gain coming from faster error correction (x112%), faster typing (x125%) and faster layout (x 110%)	10	6.3
	external correspondence		✓	✓	✓	x1.6		25	15.6
	complex tables, charts etc.		✓	✓	✓	x3	assumes mix of numbers and text in columns, the gain coming mainly from faster layout	2	0.7
								100%	41.9%

*average work mix based on survey of over 100 U.S. offices – the overall productivity gain for this work mix is 100/41.9 = 240%

Exhibit 6 Lines per day output improvement

using a regular typewriter

typing rate ch/min	lines/min at 60 char/line	typing time hr/day	lines/day
220	3.7	* 45% of 7½ hr = 3.4 hr	740

*allows for error correction, paper handling, personal time etc.

using a display word processor

productivity gain %	comments on productivity gain	lines/day
160%	non-standard internal and external correspondence – as Exhibit 5	1190
326%	standard letters, programmed correspondence and revision typing only – as Exhibit 5	2420
210%	fair expectation from average work mix, allowing for penalties including screen induced fatigue, extra control keystrokes, housekeeping, file and printer management, and time lost through equipment breakdowns.	1560

1. Improved originator productivity

The productivity of word originators – principals and other authors – can be raised as a result of:

- Reduced need for proof checking: provided the equipment is reliable, only typing work which is new has to be checked. Several users have described this as the single most significant benefit of display word processors

- The stimulus of faster turnaround resulting from improved typists' productivity.

2. Enhanced product quality

With display word processors, quality can be improved in two significant ways compared with regular typewriters:

- Appearance should be better as a result of top copies only, uniform style, freedom from correction marks, justified margins, accurate centering, emboldened headings etc.

- Content can be improved because word originators are less reluctant to request detail changes to their work aimed at enhancing the meaning of their messages.

3. Other benefits

A number of other benefits have been claimed by users, including:

- Staff turnover reduced

- Delivery time reduced, as a result both of communicating word processors, and of faster turnaround from higher typists' productivity

- Telex keyboarding saved

- Re-keying for phototypesetting virtually eliminated.

D. Payback Analysis

Exhibit 7 shows that to achieve a payback from measurable benefits in a period of three years from a display word processor, it is necessary to improve typists' productivity to about 250% of its level using regular typewriters.

In this analysis we assume the extra costs and benefits of display word processors as outlined in A and B above, and we ignore the hard-to-measure benefits. A payback analysis is simpler than ROI, and it avoids the difficulty of having to decide a service life for the equipment which is usually very difficult for fast moving technology. Three years for the payback is about equivalent to what is normally expected from other investment opportunities involving the equivalent degree of risk.

The figures in Exhibit 5 show that an improvement in typists' productivity to 250% of its level with regular typewriters can be achieved with selected work, but not generally with an average mix of work. Moreover, automatic typewriters are a cheaper alternative to display word processors for this type of selected work, as discussed in Section II A.

In conclusion, the justification for display word processors based on measurable benefits is not strong. However some businesses may be able to quantify the values of the hard-to-measure benefits and thus to improve the payback.

Exhibit 7 Payback analysis based on improved typists' productivity

	costs/benefits	yr 1 £	yr 2 £	yr 3 £	yr 4 £
costs	purchase	9000			
	insurance, maintenance (15% pchs)	1400	1400	1400	1400
	consumables	1000	1000	1000	1000
	supervision, training (30% employment costs)	600	600	600	600
	total p.a.	12000	3000	3000	3000
	cumulative	12000	15000	18000	21000
benefits	value, assuming total employment cost of £4000 pa/typist, and x250% productivity gain.				
	total p.a.	6000	6000	6000	6000
	cumulative	6000	12000	18000	24000
payback		(6000)	(3000)	0	3000

To achieve a payback at the end of 3 years, full time typists need to improve their overall productivity by 250%

VII. DEVELOPMENTS IN THE NEAR FUTURE

In this section we look at developments which are likely to occur in the next two to five years. These are mainly technical where the rate of change is very high, but we note some cultural changes as well. By viewing today's scene in the light of likely developments, a prospective purchaser will be better equipped to form judgments about equipment selection, uses and cost justification.

A. Improving The Elements

The following is a review of the main elements described in Section III.

1. Keyboard

We do not expect any dramatic changes here. Keyboards will remain electronic with mobile keys. Immobile keys are more reliable but will remain unacceptable because there is no feedback. We do not expect layouts either with separate function keypads or integrated function keys to become predominant. Nor do we expect the well-known Sholes keyboard design with its QWERTY layout to be ousted, despite its many disadvantages.

Non-rectangular ergonomic keyboards with key heights and positions more appropriate to people's unequal length fingers may find limited application; the benefit is a slightly improved typing rate sustainable over longer periods than now.

Keyboard costs will remain much the same as now and will only drop in the longer term following wider standardisation.

2. Display

We expect major developments in this area, both from improvements in the familiar CRT design, and from competing technologies; these will include solid state techniques such as liquid crystal and plasma discharge, and entirely new technologies such as lasers.

The main aims will be to cut display costs and to improve clarity; a secondary aim will be to reduce the depth of the devices. We expect these aims to be met, largely as a spin-off from growing demand and competition in the market for ADP displays. Display costs should drop about 30% in real terms in the next four years.

Display sizes ranging from a full page right down to a 'thin window' of a line fraction will all have a part to play, and we do not anticipate any particular size dominating the market. Fatigue-inducing factors will be dramatically reduced. Displays will look much more like the final printed pages in terms of typestyle, spacing, colour and clarity.

Both graphic and multi-coloured displays will start to see limited use. The aim here will be to allow users to display information which has been stored digitally from documents which have been scanned in facsimile style. Compared with monochrome text-only displays, graphic and colour displays will remain expensive and their use will be limited in the next five year time-frame.

3. Printer

While impact printers might still be in production at the end of the century, it is certain that non-impact printers will be. We expect a gradual displacement of serial impact printers by non-impact devices over the next few years for the reasons stated in Section III D.

The types of non-impact printers are diverse, as are the technologies involved e.g. thermal, xerographic, electrostatic and inkjet. Only techniques which use regular (untreated) paper are likely to succeed. IBM's commitment to the inkjet printer could mean that it will become the accepted quality printer of the next decade. Certainly its potential to produce a range of typestyles, colours and sizes under instant programmable control will give it a big advantage. Even graphic quality output from inkjet printers is a probability for the future which could threaten the whole basis of today's printing industry including phototype-setters.

However, impact printers similar to today's will remain dominant over the next five year period, because they will be cheaper as single unit devices than non-impact printers and therefore the better choice for dedication to stand-alone devices. We expect production process improvements to lead to cost reductions of perhaps 20% in petal printers, and we also anticipate similar cost reductions, and significant quality improvements, in matrix printers.

4. Storage

In the next five years developments in storage technology will lead to further cost reductions and capacity gains. These developments will occur at three levels: main storage, bulk storage and archival storage (see Exhibit 8).

– Main storage

This is storage in the capacity range of about 100,000 to 2 M bytes (10^6 – 10^7 bits), or roughly 25 to 500 typed pages of 4,000 characters. Today's most popular medium is the floppy disc. This technology has limited development potential, but is sufficiently far ahead to remain virtually unchallenged in the next five years.

We expect to see more widespread use of double sided, double density discs, with on-line cost reductions to some 100p per page p.a. Mini floppy discs are also likely to become widely used.

– Bulk storage

This is storage in the capacity range of about 2 to 1,000 M bytes (10^7 – 10^{10} bits), or roughly 500 to 25,000 typed pages. The current technology – the rigid disc – will continue to dominate. The potential for improvement lies in faster revolution speeds and higher bit-packing densities. As a result, on-line costs will reduce to 10^{-3} cents per bit on large discs, equivalent to 10p per page p.a.

However, at some point in the early 1980s magnetic bubble or some other alternative technology will replace discs, offering both lower costs and faster access times.

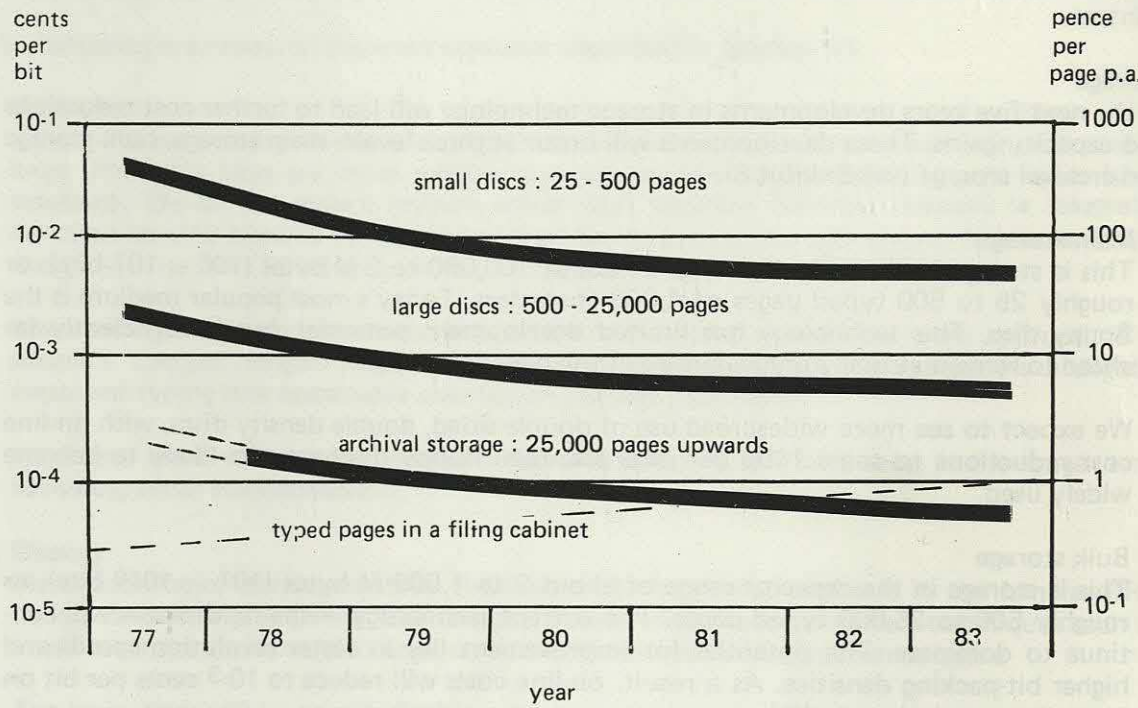
– Archival storage

This is storage in the capacity range of one billion to many thousand billion bytes (10^{10} – 10^{20} bits); 25,000 to many million typed pages.

Large discs with very high density recording – 20,000 bpi at 1,000 tracks per inch giving a total bit density of 20 million per square inch – will allow further cost reductions perhaps to as low as 5×10^{-4} cents per bit, equivalent to 5 pence per page p.a.

However, laser storage devices are already being used in special test applications at costs around 10^{-4} cents per bit. Commercial developments of those devices could bring on-line costs per page to below 1 penny within the next few years. By the mid 1980s it is conceivable that on-line laser storage will be cheaper per character than paper stored off-line in a filing cabinet.

Exhibit 8 The decreasing cost of on-line storage



Today the *cost* of storage is not a major factor in the justification for display word processors, but in future the *benefit* of cheap on-line storage will be. The new developments in archival storage will be aimed at achieving that benefit. As a result there will be much increased emphasis on:

- Remote file access and file sharing – which themselves will emphasise the need for improved communications

- File management systems which are reliable and easy to use, including indexing methods and keyword retrieval systems.

Moreover, we suspect that there will be less emphasis on COM and microfilm technologies.

5. Text handling logic and control

This will become more intelligent, and somewhat easier to use. The cost of microcircuits will continue to drop but the impact will be relatively small.

B. Cultural Developments

People's attitudes and expectations are likely to continue changing in the future, but at a much slower pace than technical developments. Their overall impact on the use of display word processors in the next five years is hard to judge, but some trends are discernible and we record them here:

- The supply of skilled typists is likely to continue to fall short of demand. This will encourage businesses both to train their own typists, and to use display word processors which enable good quality work to be produced by typists without quite the same keyboard skills which regular typewriters require.

- The continuing interest in job enrichment will lead to some pressure against limited function specialisation and large specialist groups. It is likely to be harder to create centralised typing groups than in the past. At the same time, more organisations will want to gain the cost-cutting benefits which specialist secretarial services can bring. One result will be greater interest in the compromise approach of specialist secretarial clusters (see Section V B).

- Managers are likely to continue to be reluctant to use dictation. A few will discover that they can quickly learn to type faster on a display word processor than to handwrite, and this will encourage them to do their own typing.

C. Results Of These Changes

From the foregoing we can draw some conclusions about the way display word processing will develop in the next five years.

1. Real costs will drop

The technology cost reductions described in A above will lead to a significant overall cost reduction – perhaps 20% or 30% in real terms – for display word processors. But more important than this will be the reduction in suppliers' overhead costs (particularly marketing) as the market expands. As a result the cost of today's display word processor will drop to some 50% or 60% in real terms in five years time. In practice such a large drop will probably not be apparant because – as in the ADP world – the capacity of the devices will be simultaneously enhanced.

2. Devices will be enhanced

Extended business capabilities might include a range of local processing tasks such as accounting, insurance and credit control, designed to tailor the devices to specific job

definitions which embrace more than just mere typing. Other extensions, designed for use by personal secretaries, could include administrative capabilities such as calendar information, follow up files and private directories.

Communications capabilities are certain to be expanded. More multi-location organisations will use their word processors to communicate between sites. Where this is an alternative to using the public mail service it may be cheaper; where it is an alternative to the organisation's mail system it is unlikely to be cheaper – but it will certainly be quicker. The benefits to be gained from this will encourage manufacturers to standardise on their communication interfaces.

OCR (see Section III F) is a technique which is likely to gain greater attention in future. Looking ahead to the early '80s, an alternative to OCR for non-readable fonts will be the use of digitising scanners. These will double as facsimile scanners, except that the digital pulses will be stored in the same files as text generated by word processors. It will be possible both to display these documents on adapted graphic displays, and even to print them using non-impact printers (e.g. inkjet printers) which could conceivably be the same as the standard word processor text printers.

However, a major disadvantage will remain: it will be necessary to key an identity for all documents scanned and stored in this way to allow retrieval, and retrieval by keyword will not be possible.

3. Justification will be easier

Compared with both regular and automatic typewriters, display word processors in intensive use areas will become generally justifiable for text production regardless of the work mix involved. Creating intensive typing areas will continue to be difficult, though it will still be possible. Converting equipment in existing intensive typing areas from regular or automatic typewriters to display word processors will be socially acceptable.

Multi-function workstations supporting a mix of well defined tasks will become justifiable for staff with specific responsibilities who are able to use them intensively.

Where display word processors cannot be used intensively either for text production, or for a mix of this plus other tasks in a multi-function environment, they may still be justified in some instances; for example where their communication capability can be used to replace regular mail and speed is particularly important.

Where they cannot be used intensively and benefits such as faster communication cannot be achieved, display word processors are unlikely to be justified. It will certainly not be possible to make an economic case for replacing the average personal secretary's regular typewriter with a display word processor. We do not anticipate this eventuality for at least ten years.

4. The market will proliferate

The market for display word processors will be led by the suppliers for the next five years. They will see the huge long-term potential of the business as an entry point into the total information handling market (the average business creates and uses many more words in text form than it does numbers – word processing could one day be larger than ADP).

Initially, the main targets of the suppliers will be the typing pools already created (about 700 in the U.K.) which will be ripe for conversion to shared logic systems, and the large base for automatic typewriters (about 6,000 in the U.K. some of which are already used in typing pools) which will be targets for both shared logic and stand-alone devices.

Most of the competition for the U.K. market will be foreign, and it will come from a variety of sources, including:

- Office equipment suppliers (e.g. Xerox, Philips)

- Suppliers of mainframes, minicomputers, components and terminals (e.g. IBM, Nixdorf, Wang)

- Typesetting specialists (e.g. Monotype)

- Specialists (e.g. Vydec, Wordplex).

We expect IBM to dominate the market and to influence its development as it has in ADP, and indeed in automatic typewriters.

The market is likely to stabilise within about five years, with a drop in the number of suppliers. Users will be particularly concerned to acquire equipment from viable suppliers, and they will be determined to ensure that it is cost effective. Their caution will act as a brake on market expansion, though the main determinant will be the availability of funds for investment. This will favour rented or leased equipment.

5. Equipment configuration boundaries will fade

The stand-alone vs shared logic debate will not continue more than another two or three years – not because there will be a clear winner, but because the two will merge together, becoming virtually indistinguishable.

Suppliers will offer flexible systems. Work stations will consist of keyboard, display, local storage and text handling logic – often with a dedicated typewriter quality printer, sometimes sharing printer(s) locally which may include non-impact devices. These work stations will be self sufficient, but they will also be connectable to shared file management systems. These will consist initially of large capacity rigid discs with supporting disc controllers and file management software looking after concurrent access, file management, data and file security and so on.

Effectively these systems will allow users to grow from an entry level stand-alone device to a multiple work station configuration offering the benefits of large on-line storage. All the work stations will have built-in communications adaptors, and the growth path will extend upwards to allow users to develop networks of inter-communicating work stations, and massive storage 'nodes' either shared with ADP or dedicated to word processing.

The capability of multi-function work stations will be greatly expanded as a result of developments in communications. Five years from now the most advanced businesses will be using their communicating work stations for a variety of tasks. In addition to text production, local administration and local processing, tasks are likely to include:

- interactive data entry to local and remote mainframes

- batch updating of mainframe files following local processing

- on-line enquiry to remote data and text files.

As a result of these developments, the distinction between intelligent ADP terminals with interactive capability and display word processors will fade and finally it will disappear.

Indeed, the boundaries between word processing and reprographics, OCR, facsimile and communications will also become increasingly blurred.

VIII. EQUIPMENT SELECTION AND INSTALLATION

This section provides guidelines on planning an installation and selecting the best equipment, including deciding between stand-alone and shared logic systems.

A. Planning And Implementing

1. Planning

- Establish the aims of the project, for example to reduce typing costs, to relieve a blockage, to improve correspondence quality, or to speed inter-site communication.
- Identify the departments, staffs and paperwork which will be involved.
- Measure and analyse the current work volumes, sources and timings. Allow for trends. Examine the typographic requirements and measure the current levels of typing productivity.
- Determine the expected costs and benefits, aiming for a payback on investment in a maximum of three years from measurable benefits.

2. Pilot scheme

- Gain experience by taking a work station for a pilot scheme on rental or trial period terms.
- Load the pilot work station with a sample cross section of the work planned for the main installation. Benchmark the results.
- Rotate the typists through the pilot work station.

3. Implementation

- Review the results of the pilot scheme, and the equipment selection criteria.
- With all the staff involved, agree a plan for ensuring intensive use, with minimum human adjustment.
- Establish secretarial career structures, typing grades and pay scales.
- Select the staff and supervision, and plan to redistribute any displaced staff by natural wastage, transfer or redundancy.
- Plan the work flow into, at and out of the word processing areas. Prepare a procedures manual and a training package.
- Help to ensure early success by overstaffing or by limiting the work by type or function. Monitor progress against the forecast benefits and costs, and keep the staff involved informed.

B. Equipment Selection

It would not be possible to include a comprehensive checklist of all the points to look for in equipment selection. However, there are four areas which we believe are essential and for this

reason they are summarised here:

1. **Supplier support**
   It is essential to ensure that supplier support will be both adequate and continuing. This requires continuing viability and commitment to technical support, training, engineering and maintenance. Well established suppliers which are more likely to meet this requirement in the U.K. include IBM and Philips (Xerox and Olivetti do not yet supply equipment which meets our definition of display word processors).

2. **Equipment capabilities**
   The capabilities of the equipment must align with the needs of the typing work and the business. These capabilities are certain to include text editing and typography, and are likely to include communications and storage.

3. **Ease of use**
   The equipment must be easy to learn and easy to use for prolonged periods.

4. **Cost**
   In addition to the purchase cost of the equipment, it is essential not to overlook other aspects including: the cost of consumables (e.g. printer wheels, ribbons, continuous form stationery, storage discs), maintenance, training, supervision and insurance. Other aspects are: trial discounts, rental/leasing terms, guarantees and trade-in terms.

The choice of shared logic versus stand-alone equipment is important for users with a work volume sufficiently large to occupy a number (say four or more) of work stations in one area (e.g. building).

Where an intensive typing area of at least ten regular typewriters is already established with trained staff, supervision and well developed procedures the attractions of a shared logic system are likely to be powerful. If the aim is to cut costs with the fastest payback investment, then a shared logic system is likely to be the right selection.

On the other hand, if the aim is to distribute a centralised typing service because of human difficulties, communications problems or general company policy, then stand-alone devices can offer advantages. Physical positioning is more flexible. File access is less restrictive. But it is also generally harder to ensure intensive use, so that a payback in a given period becomes less certain.

C. Learning For The Future

The cost justification for display word processors is certain to strengthen in future. Many businesses will want to take advantage of them, but as in the ADP world there will be a period of learning for even the most cautious users.

Some businesses will find that a modest investment now will allow them to gain valuable experience for the future when they will be better positioned than otherwise to reap the benefits of new developments.

IX. CONCLUSION

The aim of this report is to help office managers and system specialists answer the question 'can our organisation make profitable use of display word processors'? Our main conclusions are:

- At today's prices, display word processors are unlikely to be justified by measurable benefits alone except on selected work. For work of this sort, less expensive automatic typewriters can show a better payback, though learning to use them is generally harder.

- However, some businesses may consider that the combination of improved typists' productivity plus hard-to-measure benefits is sufficient to justify the use of display word processors. Certainly, they will need to be used intensively.

- Businesses already having centralised typing are likely to be better placed to ensure the intensive use of display word processors – either stand-alone or shared logic systems. For those without centralised typing, the human adjustments necessary to effect the change may be too great.

- However, we are at the beginning of a period of rapid technological and market developments. Within five years today's equipment will cost 60% of today's prices; and today's price will buy greatly improved technology, bringing increased benefits.

- As a result, display word processors will be readily justifiable on a range of intensive work, and in some cases with less than intensive use, though not such low use that average personal secretaries will be able to justify them. The pressure for centralisation will ease and many word processors will be distributed. Work stations will be viable as stand-alone devices but will be able to communicate with each other and with massive 'nodal' cheap on-line file storage.

- Many businesses, though unable to make a clear cost justification for display word processors at present, would be well advised to gain valuable experience from their limited use now, regarding this as an investment in the future.

- Display word processors' greatly improved cost effectiveness in the next several years is no guarantee that they will be bought. After all, half the typewriters in the U.K. are not even electric. There is a long way to go in capitalising the office, and other devices will be competing for investment resources.