THE ERGONOMICS OF DESIGNING A CD-ROM WORKPLACE IN
AN AUTOMATED LIBRARY

By

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CONTENTS

Page

iv

LIST OF TABLES

LIST OF FIGURES

Page

LIST OF PLATES

ABSTRACT

This study considers ergonomics related to the design of a Compact Disc-Read Only Memory (CD-ROM) workplace. The practical research was performed at Charing Cross and Westminster Library and Information Service which houses five dedicated CD-ROM workstations in a 'micro-lab'. The first objective of the research was to draw up a comprehensive list of specifications detailing the ideal layout of a computerized office and CD-ROM workstation. Secondly, to identify and examine the ergonomic problems in the micro-lab. Thirdly, to make a series of recommendations relating to the human factors in the micro-lab. This dissertation also asks the question, 'Why is ergonomics important?'.

The principal means of research was the interview survey technique. This was applied to obtain the views of staff and users on a wide range of human factor issues relating to CD-ROM workstation design. The interview contained questions on aspects of automation, workplace design, health and safety and environmental working conditions. There was also a period of observation when photographs were taken.

Most users had a positive reaction to the CD-ROM workplace and wanted the service extended. However,

there was concern expressed regarding specific human factor problems relating to ergonomics, workplace design and the environmental conditions. Some operators made a link between human factor issues and the health and safety problems. Consequently, the recommendations, detailing the possible improvements, outlined how the micro-lab could be relocated. They were divided into short term and long term goals.

CHAPTER ONE

Introduction

1. Introduction.

The word ergonomics is derived from the Greek *ergon*, meaning work and *Oikonomos* meaning household manager. In essence, ergonomics means the 'work and management of the household. That is, the workplace' (1). Essentially it addresses the behaviour of people and how they cope with their working environment. Its objective is to ensure that the two components are in unison. Grandjean calls this process 'fitting the task to the man' (2).

Ergonomics brings together physiology, psychology and engineering. It specifies how the ideal workstation and workplace should be arranged according to the task so that the efficiency, productivity and overall happiness of the employee increases. The term 'workstation' relates to the operator's immediate working area. In an automated library this includes the operator's personal computer, hardware, screen, keyboard, manual and source document as well as the chair and desk. Alternatively, 'workplace' relates to the whole working environment. In terms of an automated library this includes all the benching,

seating, automated equipment and the lighting, thermal conditions and decor.

1.1 State of the Art and Literature Search.

Oborne says that the rise and development of ergonomics in the United Kingdom began during the First World War and grew in popularity during the Second World War (3). By 1929 the Industrial Health Research Board employed physicians, engineers, physiologists and psychologists to investigate employment conditions and things like lighting, heating, ventilation and posture (4). The Human Research Group was established in 1949 and the following year the term 'ergonomics' was adopted (5).

With regard to this dissertation the most comprehensive research was located in a series of books by Grandjean. *Fitting The Task to the Man*, for example, presented a number of alternative ergonomic specifications (6). His more recent publication, *Ergonomics in Computerized Offices*, brought his research up to date (7). Similarly, Cakir et al put ergonomics, workplace design, health and safety into context with automated offices and highlights the need to administer a 'task analysis' before re-designing an automated office (8).

2

Pearce, in *Health hazards of VDTs?*, introduces authors who have examined the health implications of working in offices where human factors have been ignored (9). For instance, Cox documents the general implications of health in poorly designed offices (10) and Hunting shows how heavy postural loads at the VDT workstations can impair performance (11).

In the Journal, *The Electronic Library*, Bichteler discusses the effects and causes of stress (12). The human information processing system is summarized by Dyer and Morris (13). Handy (14), Maslow (15), Lawrence and Lee (16), help link motivation theory to this research. Kotler places marketing in the context of human factors in *Marketing for Non-Profit Making Organisations* (17). Although the man-machine relationship has been studied in the private sector, fewer people have applied the discipline to the library environment. Pinder and Storey explain,

> 'Observers of office automation trends will have noted a drive towards well-designed working environments for several years now. Sadly, libraries tend to lag behind with cluttered workrooms, inappropriate lighting and visually chaotic issue desks' (18).

Dyer and Morris summarize the latest research relating to ergonomics and the library environment in *Human Aspects of Library Automation.* (19). They draw together ergonomics, the human component and issues of health and safety and put them in context with different library tasks. It is a very practical book which includes a list of library equipment suppliers in the appendix. There are also a number of conference proceedings and articles in journals. These are listed in the Bibliography.

In light of new Government lending initiatives and in recognition that motivation is effected by workplace design (see Chapter 2), libraries have begun to address ergonomics. This is what has been happening at Charing Cross and Westminster Medical Library and Information Service.

1.2   Context of the Research.

The research for this dissertation was conducted at Charing Cross and Westminster Medical Library, London on the Charing Cross site. This library is part of the federal institution of the University of London. The library's objective is to support the medical school's

undergraduate and postgraduate educational and research programmes. An insight into its client base is provided in Chapter 5.

Charing Cross Library offers a number of computer services, including on-line computer searching. The library has had an on-line public access catalogue (OPAC) for three years and is linked to the Joint Academic Network (JANET) and RiverNet; an information handling network devised by British Telecom. The library database is available over JANET, accessible by the pre-clinical and other medical schools at Charing Cross. The Compact Disc Read Only Memory (CD-ROM) became part of these technological developments.

CD-ROM is a relatively new technology similar to Video-Disk, Writable Only Disc (WORM) and Compact Disc Interactive (CD-I). Data is burnt onto a compact disc which becomes a master copy from which discs can be made. The copying process is relatively cheap and is an ideal medium for distributing. The disc holds 550 million characters, or the equivalent of 200 books of 300 pages each. Hence its popularity.

Charing Cross library has five dedicated CD-ROM workstations which are all housed in a room called the micro-lab. (The term workstation relates to the

operator's immediate working area). One of these terminals iis fitted with word processing software but this is not formally offered. However, word processing tasks have been considered in the research. A full description of the equipment details and layout of the room is given in Chapter 5.

Originally Charing Cross Library had one dedicated CD-ROM micro-computer which was housed in the stationery cupboard. As the CD-ROM product developed and gained credibility more computers were added. Often a piece of software or terminal was donated by the manufacturer. Due to the shortage of space the computer terminals were moved to the relatively secure and quiet environment of the micro-lab. Gradually, as Charing Cross and Westminster Library became a test ground for new CD-ROM products and a leading authority on CD-ROM technology, the library management recognised that the project had grown out of all proportion and the micro-lab needed to be re-designed.

Hence, this dissertation considers ergonomics (human factors) associated with the design of the micro-lab. The objectives of the research were as follows:

1. To conduct a literature search. Gather a collection of articles that relate to the design

and ergonomics of automated library workplaces and
CD-ROM workstations.

2.   To draw up a comprehensive list of specifications
     detailing the ideal layout of a computerized
     office and CD-ROM workroom. Then to compare this
     dossier with the actual facilities available.

3.   To obtain the views of staff and users on a wide
     range of human factor issues relating to
     automation in the micro-lab at Charing Cross and
     Westminster Library, London.

4.   To make a series of recommendations relating to
     human factors in the micro-lab. If necessary, to
     outline the procedure if the micro-lab has to be
     relocated.

As it was said earlier, this dissertation puts
ergonomics into the context of libraries and CD-ROM
workstation design and is laid out as follows:

Chapter 2 looks at the scope of ergonomics today and
the reasons why it is important to study human factors
in the library and information service. It addresses
physiology, psychology, aspects of marketing and the
importance of the 'human component'.

Chapter 3 discusses optimum work posture, angle of
vision and examines the criteria by which the
operator can maximise her work performance in a
computerized environment. Hence ergonomic aspects of
library automation are itemized in detail. Chapter 4
applies the knowledge gained in the previous chapter
to design an ideal CD-ROM workstation. Together,
Chapter 2, 3 and 4 review the subject of human factors
and library automation.

The subject of the field work, Charing Cross and
Westminster Library and the micro-lab is thoroughly
introduced in Chapter 5. This chapter also highlights
the objectives of the research and describes how it
proceeded. A structured interview technique was
employed to gain the views of staff and users of the
micro-lab on a wide range of human factor issues. The
survey covered automation, workplace design, the
environment and health and safety issues. Secondly,
the micro-lab was compared to a list of 'ideal'
specifications.

The responses and measurements were evaluated and
discussed in Chapter 7. Finally, Chapter 8 suggests a
number of recommendations with regard to the micro-
lab which are divided into both short term and long
term goals.

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CHAPTER TWO

The Importance of Ergonomics in the Library and

Information Environment

2. Introduction.

This chapter examines the reasons why it is important
to address ergonomics in the work environment. There
are three main areas which should be taken into
account when developing or designing a computerized
work room. Each involves the study of ergonomics. The
first is the issue of health and safety, including the
legal aspect, secondly, there is the human component
and thirdly, the marketing aspect. First the health
and safety aspect will be discussed.

2.1 The Importance of Health and Safety Issues.

Problems with automation do not simply arise out of
the implementation of the machines themselves but from
the way and the circumstances in which they are used.
Grandjean, for example, talks about the man-machine
system (1). In this case the *system* is a group of
interrelated, interdependent or interacting elements
forming a collective entity. Grandjean implies that if
any part of the *system* is missing or not operating at
full capacity it will be at a cost (2). For example,

poor design, bad installation and improper use of the equipment will not only cause dissatisfaction and low morale but may also lead to illness. Hence, performance will deteriorate and there may be greater absenteeism from work (3). Therefore, the design of machines (including character size, luminance and adjustability in the case of video display units), the workplace design, (including the benching and seating) and the environmental factors, (including the thermal and lighting conditions) must be **matched** to the needs, efficiency, comfort, safety and peace of mind of users. The following section links the symptoms of poor health and safety with the design and layout of the equipment.

2.1.1 Muscular Aches and Pains.

One of the most common ailments suffered is that of muscular fatigue. This is influenced by two principal variables. Firstly, posture and, secondly, the design of the furniture. If a user adopts a 'restrictive', forward leaning posture, which puts more strain on the muscles, then she is more likely to suffer from discomfort and pain in the shoulders, neck and upper arms (4). These symptoms are compounded if the job is repetitive, uninteresting, stressful or intense.

12

The type and design of furniture and its arrangement can also cause muscular aches and pains. For instance, the use of a badly designed chair or the absence of wrist supports can cause more serious and long term ailments such as Repetition Strain Injury which includes Tenosynivitis, Writer's Cramp, Carpel Tunnel Syndrome and Occupational Servicobrachial Syndrome (5).

Hunting suggests ways in which these ailments can be removed with the provision of correct and adjustable furniture (6). The design of furniture and the whole workstation must be flexible and promote the optimum working posture which is referred to in Chapter 3 occupational health care and user friendly advice on the wall of a computer workroom can be used to educate users on how to sit properly.

2.1.2 Eye Discomfort and Visual Fatigue.

There is no scientific proof that video display unit (VDU) work damages or aggravates existing eyesight problems. However, there is a link between VDU work and Asthenopia (eye fatigue) (7).

Dyer and Morris say that eye fatigue can be caused by the constant movement of the eyes from the bright

13

source document or window to the screen as it strains the refocusing mechanism (8).

Other eye complaints include tenderness, redness, double vision and blurred vision which in turn may lead on to headaches, problems in the neck and shoulder muscles. For instance, the French Society of Ophthalmologists said that prickly eyes, headaches and dizziness were caused by (a), frequent movement of the eye between positive and negative contrasts (screen and paper) (b), image flicker (c), glare on the screen (d), dazzle from the lights and (e), indistinct character formation (9).

Eye related complaints can be prevented if attention is paid to the working environment. The Health and Safety Executive suggests that employees who wear spectacles should be discouraged from buying narrow range or multi-focal lenses and be given regular eye tests at the expense of their employer (10). On the whole the correct positioning of the VDU (slightly below eye level) and appropriate lighting (ambient lighting at half the normal office levels for negative screens) will reduce visual problems (11). Additionally care must be taken over the use of furniture especially regarding reference material which should be placed on document holders close to

the screen. The ideal specifications for computer workstations are more thoroughly investigated in Chapter 3 and 4.

2.1.3 Radiation.

VDU's do emit ionising radiation such as visible light and microwaves but the levels are generally thought to be insignificant. Some concern does exist over the emission of VLF (very low frequency) and ELF (extremely low frequency) electromagnetic emissions. However, Cox concludes that no hard evidence exists to prove that radio waves cause changes in the body (12).

2.1.4 Photosensitive Epilepsy.

Individuals who suffer from photosensitive epilepsy may experience a seizure at the terminal if precautions are not taken. However, the occurrence of Photosensitive Epilepsy ranges from 1 in 5,000 to 1 in 10,000 people. Not only is Photosensitive Epilepsy rare, but 50% experience this problem between the ages of 10-14 whilst watching the television (13). Therefore, the likelihood of a seizure at a terminal is small.

2.1.5 Adverse Pregnancy Outcome.

The alleged association between reproductive hazards and VDU work has caused the most controversy and fear. On the basis of research carried out by the National Association of Local Government Officers Trade Union (NALGO), the link between adverse pregnancy outcome and VDU work is not proven (14). However, the discussions are on-going and fears, although unfounded, are real. Since stress and anxiety can be a result of these fears, female VDU operators should be made aware of the possible health problems. After all, the stress caused by misinformation could lead to unhappy pregnancy and induce stress related problems. Signs could be put on the wall illustrating potential problems and how they can be avoided.

2.1.6 Skin Rashes.

Skin disorders can range from itching, prickling, reddening (erythema) and rashes in extreme cases. This has been found to occur when humidity is below 40% and the office is fitted with synthetic carpets (15). By addressing both of these problems the situation can be reversed.

2.1.7 Stress.

Occupational stress is found in most jobs. The effects of stress are talked at great length by Bitcheler (16). Factors such as insufficient space, inappropriate lighting, excessive noise and poor thermal conditions can cause stress in some people. So too can poor equipment design, 'hostile' rather than user-friendly software and high frequency computer failure. If the job is repetitive, monotonous and demanding, or, if the operator has no control over her work environment, then stress is more likely to occur (17).

Stress can be alleviated by paying due regard to the well being of staff. Frequent staff meetings will pave the way for better relationships and higher morale. Jobs should be well designed and both the environment and workstation must be ergonomically designed. Chapter 3 will explain the specifications of ergonomics in full.

2.2 Legal Requirements.

The rapid introduction of new technology into the work environment has heralded a new information era. This has had an enormous impact on library and information

units. It has been shown that almost as much as the computer and technology has developed, so has the worry and concern; fears about the increasing intensity of work; fears of excessive radiation emitted from the video display screens; worries over posture, eyestrain and fatigue.

There may be some grounds for these fears. In 1981 the Union of White-Collar Workers, APEX carried out a number of surveys with companies that had new technology (18). They concluded that the number of computer associated complaints was increasing but employers were ignoring them (19). This is despite the Health and Safety at Work Act, 1974, which says that employers must make sure that 'reasonable care is taken for the health, safety and welfare of his employees at work' (20). So not only do library managers need to look at ergonomics because of the impact of poorly designed equipment on the health and safety of users, but also because they have a legal requirement.

2.3 The Human Component.

The second area of concern to Ergonomists is the human component. Individuals respond psychologically to automation. They may perceive difficulties in a

18

irrational or illogical way but any worries are real
fears. Therefore human factors can have an impact on
the way users operate automated equipment. Part of the
human component is the information processing system.

2.3.1 The Information Processing System.

People process information in a set format. First
they receive stimuli from bodily receptors via the
five senses. This information is then passed to the
brain via the nervous system. Data is first stored in
the short term memory and is 'matched' to the
information in the long term memory store which has
been built up from past experience. An action is then
taken. The cycle of events is rapid but limits the
amount of information that can be processed at any one
time. For instance, Single Channel Theorists say that
individuals can only pay attention to one source of
instruction at a time and certain types of stimuli
have more impact on individuals than others (21). For
example, the intensity, continuum, mobility,
repetition, and emotional content of the stimuli or
information can have a lesser or greater impact on
the person. Also, such things as motivation, arousal,
mental capacity, perception, response mechanisms,
emotion, past experience, as well as environmental
factors can distort the initial message received in

the brain and have an impact on the level and accuracy
of use.

2.3.2 Factors that Effect Information Processing and their Implications.

These 'factors' are important and the following
paragraphs explain why managers must address them in
more detail. Essentially if management overlook the
'human component' in the design and layout of
equipment they risk low uptake of the facilities
which may then have an impact on funding.

2.3.2.1 Motivation.

Within the theoretical discipline of co-operative or
supportive management, Maslow makes assumptions about
human nature. He talks about motivation in terms of a
'hierarchy of needs' (22). At the base of the
hierarchy of needs is physiological needs, then
security needs, social needs and ego needs.
Essentially it means people will not progress and
satisfy their higher needs without first satisfying
their lower needs. In the context of work each
individual, therefore, has an hierarchy of importance.
In the theory of supportive relationships, people are
viewed with maturity. People are not regarded as

'naturally' lazy but are considered to be highly motivated *given the right conditions.*

Lawrence and Lee say that Variance theories give some particularly important insights (23). The Variance Theorists say that people consciously choose to motivate themselves but 'do not deny the possibilities of unconscious motivation or motivation through positive reinforcement' (24). The degree to which each individual does this depends on the amount of 'E' factors or, 'Energy', 'Excitement' and 'Expenditure' she is prepared to offer. The mechanism by which individuals decide how much 'E' factor they are prepared to give in a situation is called the 'motivation calculas' and is **unique** to each person (25). There are, however, three elements. The first is the strength and salience of the need, the second is expectancy that 'E' will have results and the third is that the need will be met. Motivation Theorists therefore argue that it is important to understand how people behave at work as well as how they interact with their environment and machines at a physical and emotional level. This is because each individual makes a decision about **where** they are going to put most of their energies, talents and thoughts.

If managers, therefore, have a measure of control over where individuals put their energies then it is up to library and information units to create the conditions whereby users/staff are encouraged to choose them. Thus managers of library and information services are linking pins, catalysts, mobilizers and motivaters (26). In order to motivate a manager should be concerned in aspects of health and safety, work environment, and workplace design. By effecting environmental conditions, ergonomics and health and safety issues they can make the library or information unit growth orientated. As Handy remarks, 'These methods of changing the ecology are means of changing behaviour' (27).

2.3.2.2 Arousal.

Arousal is linked to an individual's level of performance. Either too much arousal or too little can cause performance to deteriorate. Dyer and Morris give the following example (28). They say that if there are too many people using a library or information unit, arousal will be too high. Conversely, arousal will be low if only a few people are using the facilities. Like in the motivation theory, many variables, such as noise, can be manipulated to

create the most favourable and attractive environment
for users to work in.

2.3.2.3 Perception.

Perception is the ability to become aware of, to see
or notice things. The ability to perceive is effected
by the actual quality of the information and the
quality of the receptiveness. Grandjean says factors
like the size of text, glare, display
characteristics, character representation on a VDU,
noise level, vibration, inadequate lighting, poor
ventilation, and poor thermal conditions all have an
impact on a persons behaviour and perception (29).
Hence it is most important that managers of
information and library services consider workstation
design and the environment so that it is conducive to
work.

2.4 Aspects of Marketing: The Key To Good Service Delivery.

The third and final factor to be considered is
marketing. Library services are involved in a very
competitive environment and they need greater
resources to invest in new technology to keep abreast
of the market. The adoption of a high profile

approach is a useful technique to use to attract people and secure extra money from funders. Falling issue figures, the under-utilization of facilities and poor morale has also meant that non-profit making organisations have to attract a larger client base. To survive, institutions must know their market, attract resources, convert resources into products and distribute them.

Kotler quotes eight other situations in which the marketing technique can be used and adapted (30). For instance, if there is negative demand, the product must be redesigned and re-marketed; where there is latent demand the institution can measure the potential market and discover its needs; where there is falling demand the institution can promote the product. The marketing 'plan' also allows non-profit organisations to become more visible, relevant and efficient. Effectively, library and information services can be more responsive, adaptive and entrepreneurial.

Marketing is a mutual, voluntary relationship between the users or potential users and the library and information service. It is an 'exchange mechanism' rather than a 'threat system' (31). Marketing uses a set of tools known as the 'marketing mix' (32). These

are product design, effective pricing, promotion and place (distribution).

Therefore, part of the marketing plan is service design which involves product quality. A manager can measure quality by examining user satisfaction or by considering the product in terms of its accessibility, and the competence, courtesy, reliability, responsiveness and understanding of its staff. Other tangibles include the upkeep of the equipment and 'atmospherics'. Atmospherics is a complex mix of the setting, layout, comfort, adequacy and convenience of the furniture. For example, Kotler defines atmospherics as,

> '...the designing of buying and consuming environments in a manner calculated to produce specific cognitive and/or emotional effects on the target market' (33).

The workplace and workstation should not only be safe but practical and aesthetically pleasing. Ergonomics is on the agenda once again.

2.5 Summary.

Applying ergonomic principles to the work environment adds costs to the implementation of technology but, in the long term, is likely to prevent health problems, improve performance, increase staff and user satisfaction and, therefore, create demand and attract funding. It will also add to the overall marketing plan. It is important that ergonomics is put onto the agenda and library and information units do not fall behind the private sector.

The following Chapter discusses optimum work posture, angle of vision and examines the criteria by which the operator can maximise her work performance in a computerized environment. Hence, the ergonomic aspects of library automation are itemized in detail.

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CHAPTER THREE

The Ergonomics of Library Automation

3. Introduction.

Mason reports that ergonomically designed furniture can increase productivity by 10-25 per cent (1). Certainly good workplace design can reduce the incidence of illness, improve morale and increase performance (2). Since staff and users are the essential ingredient in any library and information unit, it is absolutely essential that their comfort and safety is maintained. So, although the application of ergonomics to the work environment will initially increase costs, in the long term it will make good financial and managerial sense.

The previous chapter also argued that managers must address product design within the context of a marketing plan and adhere to the Health and Safety at Work Act, 1974. Hence, all institutions should ensure that the workplace is suited to the efficiency, comfort and safety of staff and users.

The following chapter discusses the optimum working posture and angle of vision. It also examines the criteria by which the operator can maximise her work

performance in an automated environment. Hence, the
ergonomic aspects of a computerized workstation are
itemized in detail.

3.1 The Optimum Working Posture.

3.1.1 Seated Position.

In the case of shared workstations, people using the
equipment vary in size and shape. Therefore, it is
important that the workstation is flexible and
adjustable.

Incorrect sitting posture can cause backache,
headaches and discomfort in the neck and shoulders
(3). It can also cause digestive and circulatory
problems (4). The ideal posture for the back is one
that allows the person to adopt a slightly curved 'S'
shape, similar to the curve adopted in the standing
position (5). This posture does not require muscular
tension and does not allow the back to slump. Thus,
it prevents unnecessary pressure being placed on the
intervertebral discs.

There are several alternative sitting postures which
provide comfort and support (6). In the context of
this study the 'upright' posture has been selected as

adequate. In this position   the back is erect, the
thighs are horizontal, the knees and elbows are bent
at right angles and the forearms run parallel to the
thighs. This sitting posture is illustrated in Figure
1.

3.1.2 Arm Reach.

A poor sitting posture is aggravated by the operator
lifting heavy objects or turning the torso from side
to side. Therefore, all pieces of equipment need to
be placed within   comfortable reach of   the VDU
operator so that no unnecessary stretching takes
place. The most frequently used items of equipment
such as the screen, controls (including brightness,
contrast and ON/OFF switch), source document,
telephone, floppy disc holder, printer and personal
belongings   must   be   within   the   optimum   reach
measurements.   They   must   be   placed   according   to
importance, function, frequency and sequence of use.

Table 1 summarizes the maximum vertical and
horizontal reach requirements. It takes into account
the problem of equipment being above and forward of
the operator.

Type	men	women
Maximum vertical sitting reach	119 cm	107 cm
Maximum vertical standing reach	195 cm	178 cm
Optimum horizontal reach	— 35-45 cm	(relaxed arm)
Maximum horizontal reach	— 55-65 cm	(straight arm)

Table 1 Vertical and horizontal reach distances (adopted from Grandjean (7)).

3.1.3 Angle of Vision.

The distance from which the operator can see the screen depends on their eyesight, the quality of the display screen and lighting. It is recommended that the operator sits within 61-93 cm of the screen (8). Secondly, all items of equipment viewed regularly should be between five degrees above and 30 degrees below the horizontal plane (9). This will minimize head movement and reduces the risk of muscle fatigue. For instance, if the screen is too high the operator will be forced to look up for long periods of time which can cause stiff neck and eye strain. The optimum sitting posture and angle of view is illustrated in Figure 1.

ADJUSTABLE
BACK REST, MIN.
36 CM WIDE X
32 CM HIGH

20°

SEPARATE
KEYBOARD

LEVEL
FOREARMS
AND HANDS

HEIGHT OF
REACH
220-250 MM

SEAT,
MIN 40 X 45CM

ADEQUATE
KNEE CLEARANCE

SEAT HEIGHT
ADJUSTABLE FROM
SITTING POSITION

FIVE - WHEEL BASE
STABILITY

ADJUSTABLE
FOOT REST
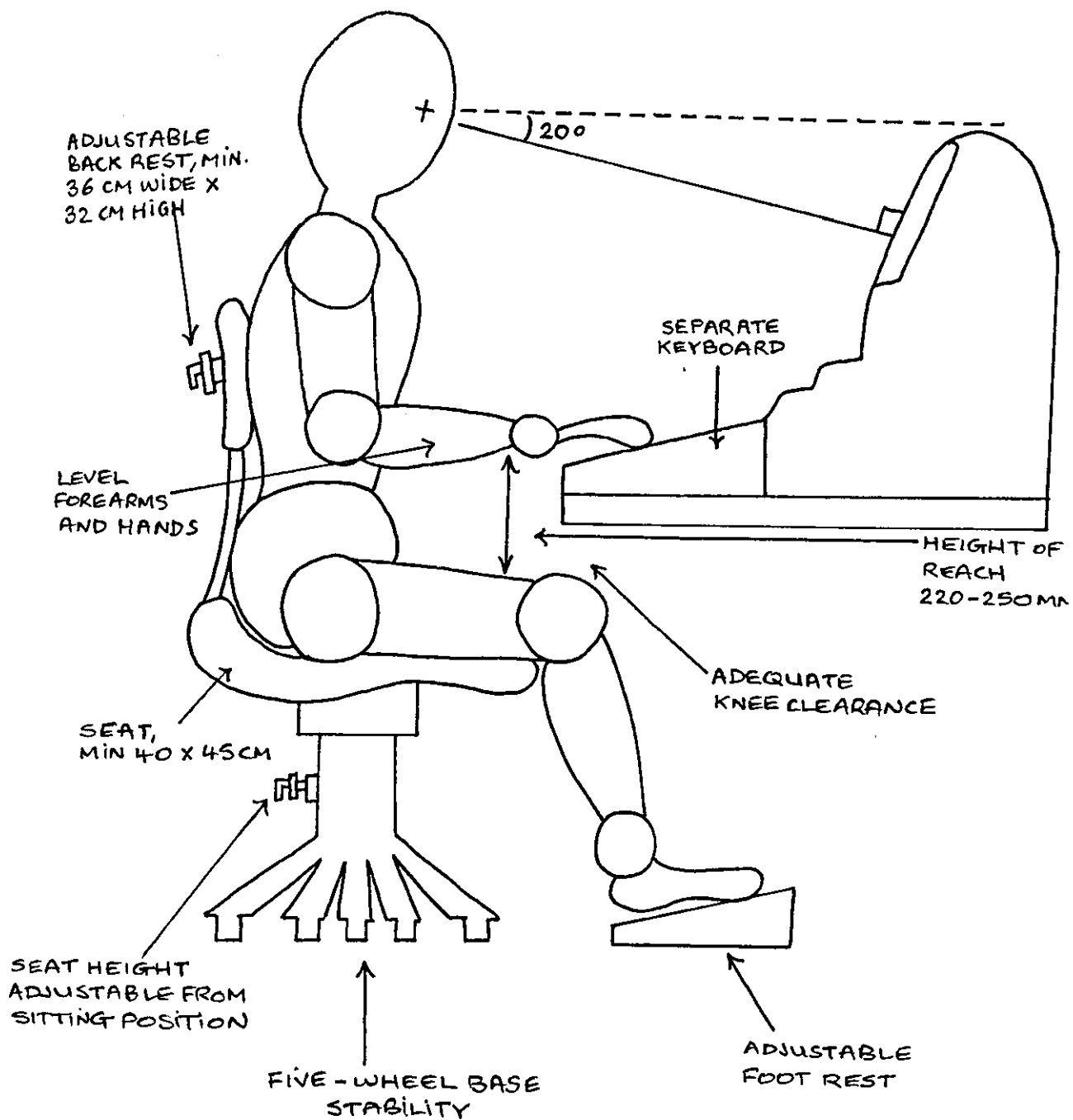
Figure 1 Optimum work posture (adapted from Cakir
et al (10));

33

3.2 Workstation Design.

3.2.1 Task Analysis.

If equipment is placed according to the way in which it is used, time can be saved and movement between tasks will be far smoother. Hence, before a manager can re-design an automated office she must understand how the workstation will be used. That is, she must find out the age, sex, fitness of users and whether they are left or right handed. A manager must also consider the length of time spent at the computer, the number of different tasks performed (especially the proportion of VDU work and non VDU work), the frequency with which the task is carried out and the sequence of events. Most importantly she must assess the category of work, and the communication and equipment needs. This process is known as the task analysis.

If a manager considers the category of work the equipment can be organised according to the use made of the keyboard, screen and source document. For instance, data entry work largely involves the input of data. It involves putting written work from a manuscript into a word processor. The operator will normally be a skilled keyboard user and spend most of

34

her time looking at the source document, with occasional glances at the screen and keyboard. The source document and keyboard should be placed in front of the operator and the screen to the side (11).

Data enquiry work involves an operator calling up specific information. The keyboard is not used very often and only part of the screen is scanned. Some note taking also takes place. Hence, the screen and keyboard should be placed in front of the operator and the document to the side (12). Printers should be placed within the maximum arm reach.

Interactive work combines data input and data enquiry. Key speed will be slow and the operator will probably scan the keyboard to check accuracy. The screen and keyboard should be placed in front of the operator and the document to the left hand side (13). Alternatively, the source documents can be placed between the screen and keyboard (14).

A manager must also assess the level of communication at each terminal. For example, if training takes place in the workplace, more 'access' room will be required and wider and longer desks. Finally a manager must assess the equipment needs. That is, the electrical, machanical and communication features.

When all these requirements, and physical limitations
are considered, then the manager can go on to design
a workstation that is ergonomically comfortable,
relevant and efficient in its operation. The following
section itemizes the workstation measurements.

3.3 Furniture Considerations.

Technology changes rapidly so it is imperative that
the furniture is flexible, modular and completely
adjustable. An open workstation must be able to
accomodate all sizes of people and all the jobs
highlighted by the task analysis. The workstation
must also cater for less obvious requirements such as
storage and cleaning needs.

3.3.1 Chairs.

Seating must be stable and adjustable. That is, the
operator should be able to change the forward,
upright and back leaning positions as well as the
height of the chair. Ideally, the operator must be
able to make the adjustments in the seated position.
The chairs recommended characteristics are adopted
from Cakir et al as follows (15):

* Stable five legged castor base.

36

* The distance between the surface of the chair and top of the backrest should be 48-50cm in height and 32-36 cm wide.

* The lumber pad should be concave and positioned 10-20 cm above the seat surface.

* The seat should be at least 40-45 cm across and 38-42 cm from the front to back.

* The seat should be fitted with a waterfall edge and be upholstered.

* Finally, it should have a swivel seat.

3.3.2 Desks.

For keyboarding tasks the desk surface should be large enough to accommodate the screen, keyboard, printer, source document and manual. All the equipment that is frequently used needs to be accessible from the seated position. However, a cluttered desk will reduce mobility and restrict body movement. Hence, the recommended width, depth and height of the desk is 120-160 cm, 90 cm and 720-750 cm respectively (16). Desks should be placed at right angles or 45 degrees to each other and the underside of the desk should be free from obstruction (17). The desk should also be 2.5 cm thin which will allow mobility and provide support for equipment (18). If the desk is high, the seating poor and their is no footrest then the

37

operator will hunch her shoulders which in turn will cause muscular fatigue. The 'home row' of keys (middle row on a keyboard) should be level with the elbow so that the operator can adopt the optimum sitting position. Table 12 summarizes the preferred seat, table and keyboard settings.

Specifications	Data
Keyboard height (floor to home row)	70-85 cm
Keyboard (home row to table edge)	10-26 cm
Screen height (Screen centre above floor)	90-115 cm
Screen distance from table edge	50-75 cm
Distance between floor and seat surface	38-54 cm
Distance between seat surface and desk top	48-50 cm
Distance between seat and underside of desk	17 cm
Height of desk	72-75 cm
Width of desk	120-160 cm
Depth of desk	90 cm

Table 2 Preferred seat, table and keyboard settings (adapted from Grandjean (19)).

38

3.3.3 Cabling and Other Considerations.

Poor cabling is hazardous. Not only can faulty and loose wiring harm operators, it can also destroy equipment. Hence, wiring should be unobtrusive, adaptable, well planned, and the plugs should be labelled. The only way to do this is to get expert help and advice from a qualified electrician. To prevent surges of electricity, dedicated power lines should be fitted from the main source. Also, to reduce static, special 'low static' carpets can be bought or rubberized anti-static mats can be fitted. Humidity should also be kept low by reducing heat output and placing blinds at the window. Finally, managers must consider buying security for the computers.

3.4 The Visual Display Unit.

3.4.1 Display Screen.

Lighting, pupil size, retina adaptation, defective vision, sex and age can induce and aggravate existing eye sight problems [20]. The photometric character of a VDU display screen and poor character legibility will cause visual discomfort [21].

3.4.1.1 Character Formation.

Mutter et al confirmed that vertical spacing of characters is linked to slow reading (22). Dainoff et al also observed that people working at older VDU's experienced more visual problems than those working at newer models (23). Other research shows that poor lighting, unclear screen quality, and poor character contrast can impede operator speed, damage the retina and cause visual fatigue (24).

It is important that there is sufficient space between lines of written text so that words can be distinguished. The characters on the screen need to be well colour contrasted (preferably yellow or green on black) and the luminance levels need to accommodate personal preferences. These provisions will increase reading speed as well as reduce the chances of eye strain.

The VDU characters are made from phosphor. This is constantly shot from a 'gun'. Once the phosphor fades the glow fades, so the 'gun' is shot again. The replenishment rate on a computer is normally 50-60 Hertz per second (25). If the replenishment rate is any lower, the character image will flicker (26). The phosphor also decays with time, so the quicker the

rate of decay the more the screen needs to be replenished, the greater the chance that the screen will flicker. Highly persistent flicker can cause ghosting. This is when the old image is left on the screen when the screen is rolled. Also, if the electron beam does not travel across and down the screen effectively, the characters will appear to move. Not only can these symptoms be annoying but they also cause visual fatigue. The refresh rate and phosphor decay time should not be less than 80-100 Hz per second (27).

There are several methods of creating characters on the screen. The most common method is dot matrix generation. This is when the dots are divided into a rectangular matrices of 5/7 or 7/9. The characters with 7/9 dot matrix formation are clearer because the dots are closer together. Consequently, the screen can be read both quickly and easily, visual discomfort is reduced and performance is increased (28).

Computers that do not have a correct character font will not have clear ascenders and descenders. When buying a computer it is important to check to see if certain letters are distinguishable from each other. For example, the O and the Q, T and Y, S and 5, I and

41

L, X and K, I and 1 can all be hard to distinguish.
The character must also be sharply defined and not
have blurred edges. Squarer characters are also easier
to read than tall and thin characters (29). Hence,
the text is legible, reading speed quickens and eye
strain is controlled. The recommended size of screen
characters is summarized in Table 3.

Screen Character Dimensions	Recommendations
Height of capital letters	3-4 mm
Width of capital letters	75% of the height
Height of lower case letters	70% of capital letters
Width of lower case letters	60% of capital letters
Stroke width	20% of the height
Intercharacter distance	25% of height
Interline spacing	4-6 mm or 100-150% of the capital letters

*Table 3 Summary of character measurements (adapted
from Grandjean (30)).*

3.4.1.2 Positive Versus Negative Screens.

Most VDU screens have light lettering on a dark
background (positive screen) rather than dark

42

lettering on a light background (negative screen).
Positive screens require lighting that is less bright
than natural light so that contrast between characters
is maintained. There are two problems with this.
First, the user has to constantly look from a dark
screen to a light source document. Secondly, lower
lighting levels will make the source document harder
to read.

None of these problems are experienced with a negative
screen. Operators often feel that negative screens are
more comfortable to use (31). Certainly a bright
screen backing reduces the luminance contrast between
screen and source document and reduces pressure on the
retina. The amount of reflection on a negative screen
is less than on a positive screen. The general
illumination of the office can be increased so that
both the source document and screen contrast ratio are
good. However, on a negative screen, the characters
appear to be slimmer than they are. Consequently,
characters are less clear and the white phosphor is
less persistant. Therefore, flicker is more likely to
occur. As a result, negative screens often reduce the
operators performance and productivity (32). Nobody
has yet decided which screen is preferable.

3.4.1.3 Cursor.

Dyer and Morris quote four qualities which the cursor should have (33). They need to be:

* clearly located on the screen

* easily tracked

* completely distinguishable from all other characters on the screen

* unobtrusive

* a unique shape

3.4.1.4 Miscellaneous.

Finally, the screen should swivel and be easily tilted up or down to enable head on vision. This is especially important at a workstation that is used by many people of varying sizes. Where this is not possible, management should purchase a turntable. The major controls should be colour coded and all the buttons should be easily reached from the seated position.

44

3.4.2 Keyboard.

There is a lot of discussion about the ideal layout of the keys. Grandjean advocates an ergonomically designed keyboard that is angular and does not constrain body movement (34).

In the United Kingdom, however, most keyboards are fitted with the Qwerty layout on a standard rectangular keyboard. So-called because the first six letters on the top row spell 'qwerty'. This was designed by the Shole brothers for accuracy rather than speed (35). However this design can cause Repetative Strain Injury (36). Since it is the most popular model and researchers have not yet reached any conclusions on the design of an ideal keyboard, the qwerty keyboard is recommended. It is more important that all keyboards are identical in the work room so that users can move between them without any undue problems.

Table 4 summarizes the recommended measurements for keyboards. All the recommendations are made with respect to speed and efficiency as well as concern for the operators posture.

Specification	Data		
Keyboard height above desk (middle row)	30	mm	(37)
Distance between keytops	17-19	mm	(38)
Top of the key	113	mm	(39)
Key radius	10	mm	(40)
Distance of Key travel	3-5	mm	(41)
Keyboard height	2.6	mm	(42)

Table 4 Summary of key measurements.

CD-ROM software requires certain function keys that are pressed more than others. These keys need to be distinct from other keys by colour and position. Guidelines outlining the function keys need to be posted near to each terminal. This will maximize the efficient use of the keyboard, increase efficiency and create a more user friendly environment.

For flexibility, the keyboard should be stable and connected to the screen by a lead. The thickness of the keyboard will effect the height of the home row keys which in turn will effect posture. Thicker keyboards will need the addition of wrist supports (see below). The keys should be concave, resistant to

knocks and matt finished. Black lettering on a grey background is preferable. The keyboard should be fitted with tactile feedback at the point of acceptance with the option to turn it off. This audible message helps operator accuracy. An audible warning bell should also be fitted to the computer so that the operator knows when the computer can not complete a transaction or when two keys have been pressed simultaneously.

The function keys that destroy work must be clearly set apart from the frequently used keys. Grandjean says that pressure on the interverbral discs and the likelihood of shoulder muscle strain is reduced if forearm rests are provided (43). If there is no room between the keyboard and edge of the desk (which can offer arm rest support) then wrist supports should be considered.

3.4.3 Printers.

Printers must produce reasonably good quality work and should be fairly quick at producing it - quietly! Slow printers can be frustrating and time consuming. Noise can be the greatest hindrance in a library environment. Ideally non-impact printers should be installed in rooms were users want to concentrate or

where dialogue needs to be heard. For example. during a training session. However, this is an expensive way of printing, especially if the copy will be thrown away.

Daisy wheel printers (impact printers) are far noisier but cheaper. Printer noise can be reduced by 90% by fitting it with an acoustic hood (44). However, the frustration at removing the hood after each print-out might outway the disturbing effects of the noise. Simply placing a mat between the printer and the table will reduce vibration. If the printer is not used often and it is networked, can be placed in another room.

3.5 Environmental Factors.

3.5.1 Lighting.

It is important that illumination levels, light sources, light colour and light glare are considered in an automated office because poor lighting can result in visual discomfort and poor performance.

Illumination is the level of light falling on a surface and is measured in units of lux. Alternatively, luminance is the level of light

48

emanating from the surface and is measured in candles per square metre. Reflectance is a percentage of the reflected to incident light.

There are two types of lighting - direct and indirect lighting. Direct lighting sends 90% of the light to its target (45). As a result there could be shadows, high contrasts and glare on the screen and source document. It is, therefore, an unsatisfactory way of illuminating a computerised office. However, it can be more effective if it is used with indirect lighting.

Indirect lighting is light which is reflected back into the room from the walls or ceilings. This light source resembles natural light so the whole environment is evenly lit and there is a reduction in glare. For example, uplighters allow 40-50% of diffuse light to radiate outwards to the ceiling, floors and walls (46). However, indirect lighting will not highlight the source document enough to prevent visual fatigue. Consequently, as the lighting is reduced, local, directional lighting needs to be introduced so that source documents can be easily read.

Most lighting in offices comes from fluorescent tubes. When they are covered they have a high output, long

life and simulate natural light quite effectively. They are also cheap to run. However, fluorescent tubes often flicker. Consequently the retina is repeatedly over exposed. This can cause discomfort, headaches and visual fatigue which, in turn, reduces operator performance. Hence, fluorescent lights should be regularly maintained. Ideally a combination of indirect and direct lighting should be fitted.

Direct glare from light sources falling in the operators vision can be very serious and is an important ergonomic consideration when dealing with offices which house VDT's. Operators should be placed at a right angle to the light source (window and electric light fittings). Computers should not be placed in front of the window because characters on the screen will be hard to see and the retina will have to continually readjust to scan a relatively dark screen and then a very bright source document. Reflective surfaces should not be in the operator's line of sight and all lights should be fitted with anti-glare shields. Anti-glare shields can also be fitted to the terminal screens. Finally, vertical blinds, which do not block out the sun, can be fitted to the windows.

Sharp luminance contrasts between surfaces can reduce visual comfort. To avoid this, the following precautions need to be taken. All the points are adapted from Grandjean (47).

* All large surfaces should be equally bright.
* All surfaces in the visual field should have a contrast of no more than 3:1 and work areas should be bright in the middle and dimmer at the side.
* Light sources should give out continuous light and maximum brightness contrast should not exceed 40:1
* Bright worksurfaces contrasting with dark floors should be avoided.

Cakir et al recommends 300-500 lux as a suitable level of illumination in an automated office (48).

3.5.2 Decor.

Ceilings should be painted white and floors should be covered in carpet which absorbs noise and light. All the colours should be harmonious rather than contrasting and of a similar brightness. In a computerised office, an intermediate colour (blue/green) is recommended. This will not make the

room look drab or make it feel too cosy! It will also make a small room look larger, colder and restful.

3.5.3 Noise.

Noise levels are inhibiting when they cause hearing damage and effect concentration. In the library environment a ringing phone, noisy printer, whirring fan or cooling system, photocopier or conversation can cause the loss of concentration, poor communication, frustration and stress.

The level of annoyance depends on the following things. Firstly, the nature of the noise; high pitch and irregular noise patterns are more annoying than low pitch noise. Secondly, noise approval; if the operator is involved in the noise then the sound will not be as irritating. Thirdly, if the noise is imposed on the operator it will be more disturbing. Some background noise may be a comfort to workers. The level of noise is also affected by the rooms acoustics and the type of surfaces in the room. Carpet and hession wall coverings will absorb noise more than metal or stone which will reflect and enhance noise. The layout of the room will also effect the way noise can travel. In a quiet reading room in a library

shelves can be positioned so that they stop and absorb noise before it reaches the quiet area.

There are other ways of cushioning the effects of noise. The first is to make sure that equipment is maintained and old equipment is regularly replaced. The acquisition of acoustic hoods for noisy printers is also an advantage. If possible, the printer should be networked and isolated in a different room. Certainly managers should purchase 'noiseless' printers which are now on the market. Noise absorbers, such as carpets, double glazing and ceiling tiles will alleviate the worst effects.

3.5.4 Thermal Conditions.

Temperatures should be maintained at between 21 and 23 degrees centigrade (49). Staff do not legally have to work in temperatures below 16 degrees (50). To avoid 'hot spots' blinds can be fitted at the windows and computers can be spaced apart so that cooler air can circulate.

Relative humidity should not fall below 50 per cent (51). A dry atmosphere can cause a dry throat and nose. A simple precaution is to purchase humidifiers or plants which make an atmosphere moist.

Air should not be too still or too draughty. Fans, which move the over the skin much more quickly and cool operators down, are worthy investments.

Poor thermal conditions can be alleviated with proper due care. Blinds at the windows, the correct positioning of computers and consultation with staff will alleviate the worst effects of poor thermal conditions.

3.6 Summary.

This chapter has discussed optimum work posture and correct angle of vision. It has also examined the criteria by which the operator can maximize her work performance in an automated office by examining the equipment including, the terminal, workstation and workplace. Chapter 4 applies the knowledge gained in this chapter to design an ideal CD-ROM workstation.

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CHAPTER FOUR

Workstation Layout for CD-ROM and Word Processing

Tasks

4. Introduction.

The previous chapter discussed the optimum work posture, angle of vision and examined the criteria by which the operator could maximise her work performance in a computerized environment. Hence, the ergonomic aspects of library automation were itemized in detail. These measurements and specifications must be considered in conjunction with this chapter which examines the sequence of events, equipment needs and hardware needs carried out at a CD-ROM terminal and word processor. This is followed by diagrams which illustrate the ideal layout of the equipment.

4.1 Length of Time at the Computer Terminal.

Open access CD-ROM searching can involve an operator in work that lasts from five minutes to two hours depending on the intensity and nature of the task. Word-processing is more likely to involve the operator in work that lasts at least thirty minutes to a whole day. Hence, the equipment should be ergonomically designed and made available for long periods of time.

4.2 Sequence of Events.

The operator at a CD-ROM terminal will sit in front
of the machine with her personal belongings. She may
adjust the screen and seat and rearrange the desk to
suit her requirements. The user may have to fill out a
diary recording the visit and consult a manual on how
to operate the machines and a thesauri before
commencing the search proper. Hence, the operator
should be able to make any adjustments from the seated
position. The instructions describing how the
adjustments can be made and how to use the equipment
should be posted nearby. Also, the desk should
accommodate both left and right hand users and have
storage space for personal belongings. Finally the
manuals should be placed within the optimum arm
measurements.

In conjunction with her notes the user will then
proceed to carry out the search strategy. It might be
necessary for the user to run another compact disc.
Unless the operator is working at a four disc drive,
she will have to save the search, exit from the
software and re-load the new software before she can
continue. The compact discs need to be within the
optimum reach requirements (see page 32).

Most people complete a search by printing off the 'hits' on an accompanying printer. The user may then temporarily leave the terminal to look for the cited articles before returning to complete the search. Hence, there must be enough space to manoeuvre between terminals. The printers should also be within the optimum arm measurements, discussed in Chapter 3.

With respect to word processing tasks, the operator will probably complete a booking form and consult a manual before commencing loading the software. Once the software is loaded, in conjunction with her source documents, the operator will key in text. Once the text has been keyed in, the work will be printed out. Normally a manual is consulted during the whole process. Hence, the desk must be large enough to accommodate both left and right handed users, a copy holder and the hardware. There must also be enough space for the operator to write in.

4.3 Equipment Considerations.

Paper, copy holders and manuals are necessary in both word processing and CD-ROM searching and should be placed within the optimum arm reach measurements.

59

4.4 Hardware Requirements.

Most CD-ROM products run on IBM XT or compatable machines. Most of the products require a colour monitor, a micro-computer with a CD-ROM drive and an interface/controller card which resides in the micro-computer. This facilitates the link between the two. The choice of software is dictated by practical requirements. For example, a RAM size memory of 640 or 512K may be required (1). Drives can be separate from the micro-compouter or an integral part of it. Separate units can be top or front loading. The workstations must also have a print facility.

For word-processing tasks, hardware requirements will include a hard disc, colour monitor, and keyboard. The workstations may also have a printer.

4.5 Software Requirements.

The present and back copies of the compact disk need to be positioned in close proximity to the terminal so that they are easily accessed from the seated position.

4.6 Security Needs.

Where it is not possible to have supervised work rooms, the terminals need to be fixed to the desks or fitted with an alarm so that they can not be stolen.

4.7 Training Requirements.

Training requires that the working area is quiet and that there is access space so that operators and trainers can easily move around. It is also important that the room is large enough to accommodate extra seating and larger desks. The notices for operating the units also need to be prominent, eye-catching and 'user friendly'.

4.8 Category of Work and Position of the VDU.

4.8.1 CD-ROM Work.

CD-ROM work is largely an enquiry task. Therefore, little use is made of the keyboard and the operator mostly reads from the screen. The operator will probably note down what happens on the screen at the left or right hand side. Print-outs need to be easily accessible from the seated position. Space for the thesauri and manual must be available within arms

61

reach. If training takes place in the same room then space is required so that clients can maneouvre. Figure 2 shows the workstation design for enquiry work.
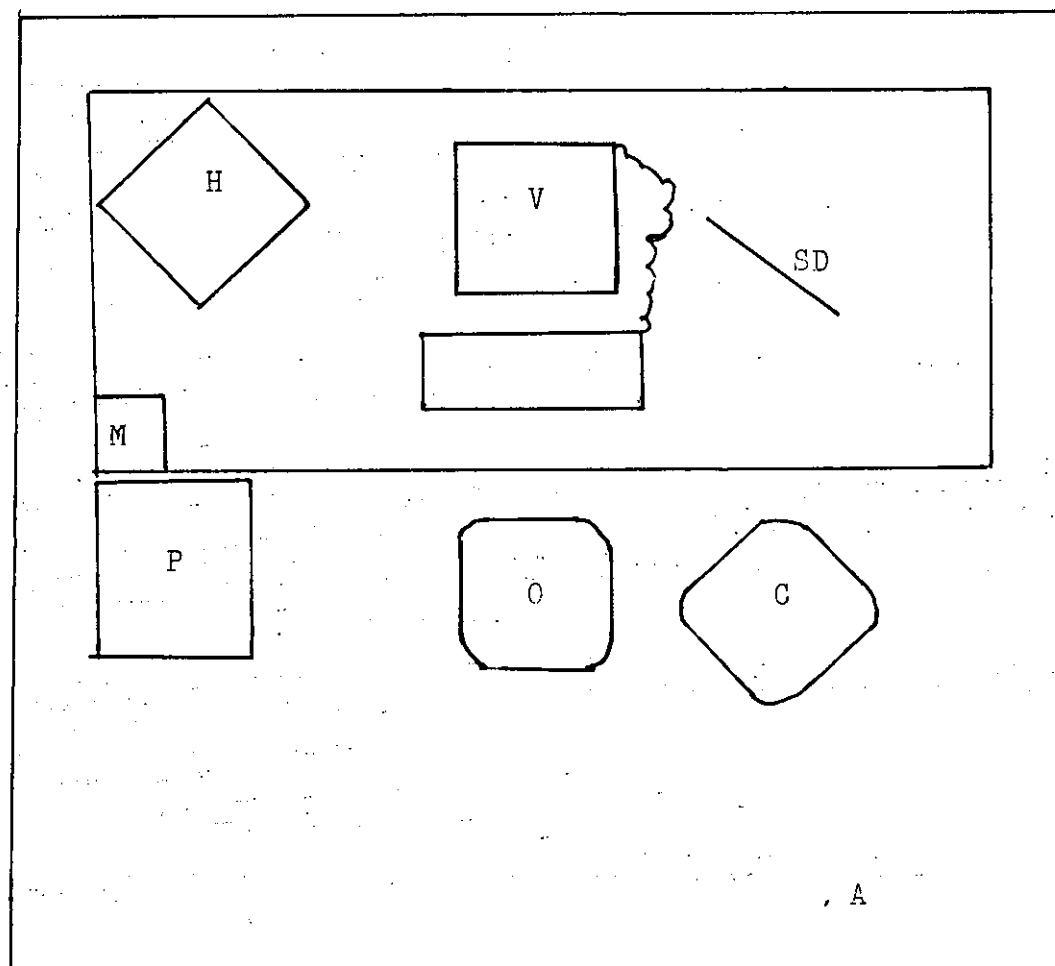
Key: A = access space, C = client, H = hard disc, M = frequently used manuals, O = operator, P = printer, S = shelving, SD = source documant, V = VDU,

Figure 2 Layout for an open access CD-ROM workstation (adapted from Dyer and Morris (2)).

4.8.2 Word Processing Tasks.

Experienced keyboard operators will usually concentrate on the source document with occasional glances directed at the keyboard and screen. That is, an experienced operator will spend approximately 70-80% looking at the source document, 15-20% looking at the display screen and 3% of her time looking at the keyboard (3). However, in an open access workroom, generally operators will not be professional typists or experienced keyboard users. Hence, keyboard speed will be slow and operators will look at the keyboard as well as the screen and source document. Generally, 35% of her time will be spent looking at the source document, 30-40% will be spent looking at the display screen and 20-35% of the time will be spent looking at the keyboard (4). Therefore, the workstation should be flexible so that it can be altered to suit left and right hand users. The source document and the keyboard should be placed in front of the operator and the screen should be placed to the left or right hand side (5). Alternatively, the source document should be placed between the screen and the keyboard (6). Figure 3 shows the ideal layout of the workspace for data entry or word processing tasks.

A

B
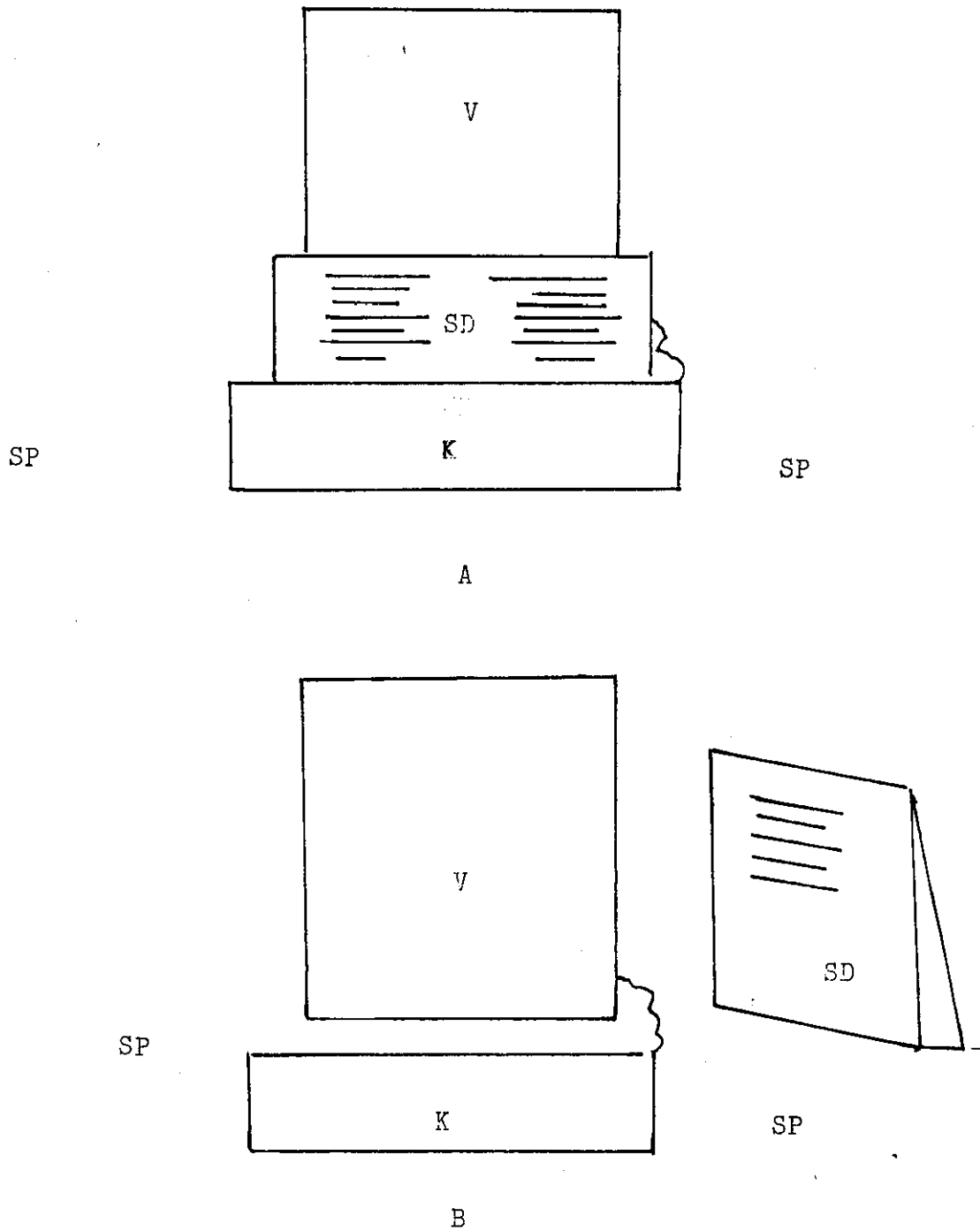
Key: K = keyboard, V = VDU, SD = source document, Sp = space for working materials.

Figure 3 Alternative layouts for data entry work (adapted from Dyer and Morris (7)).

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CHAPTER FIVE

Field Work

5.   Introduction.

The research for this project was conducted at Charing
Cross and Westminster Medical Library and Information
Service which is situated in the London Borough of
Hammersmith and Fulham. Chapter 1 outlined the
objectives of the library and provided an introduction
to the library's computer facilities and the CD-ROM
product. Also, it briefly introduced the micro-lab and
referred to its evolution. This chapter provides
readers with a greater insight into the client base,
the specific equipment details and layout (including
diagrams) of the micro-lab. It then goes on to discuss
the field work and the type of sample and tests used.

5.1   An Introduction to Charing Cross and Westminster
Medical Library and Information Service.

5.1.1 Client Base.

The Charing Cross site has a staff of eight full time
workers and six part time workers. There is the
Librarian, a Secretary, a Senior Assistant Librarian

and two Assistant Librarians. The remaining staff are Senior Library Assistants.

The library supports 800 students plus teaching and research staff from the medical school and staff from the hospital. Paramedical staff, including physiotherapists, occupational therapists, dieticians and radiographers, also use the facilities. In July 1987 the Library sub-committee approved a new category of associate member. This allowed medical professionals from outside the hospital to use the library for reference purposes (1). The library also supports the Regional Neurosciences Unit, the Gunnar Nielson Radiotherapy Department and the Department of Medical Oncology. Therefore, The library is a popular resource amongst the hospital community. The issue figures in 1987/88 stood at 19,703 (2). In 1987 requests for inter-library loans had increased. This increase may in some part be a result of the CD-ROM product which cites journals not held by the library, although research needs to be done to prove this (3).

Clinical professionals need to access up-to-date information quickly so that they can keep abreast of new developments in the medical world. For example, professionals will often scan at least 15-20 titles each month (4). Also, medical school staff involved in

67

on-going research need to access original work. All
this information needs to be communicated rapidly and
accurately. Hence, the CD-ROM service is popular
with clients who have very little time to spare. The
CD-ROM's are housed in the micro-lab.

5.1.2 The Micro-lab.

Chapter 1 explains that the micro-lab provides a user-
friendly environment which supports five CD-ROM
workstations. The micro-lab is situated on the second
floor in the library. Figure 4 demonstrates its
position with regard to the other library facilities.
It is open during normal library hours. The
workstations can be booked in advance and one hour
training sessions are available which normally have
to be pre-arranged.

5.1.2.1 Layout of the Micro-lab.

It can be seen from Figure 5 that the micro-lab houses
five dedicated terminals which are arranged at
'workstations'. Fluorescent lights are positioned at
right angles to the light source and parallel to
workstations one, two, four and five. The micro-lab is
carpeted and painted grey. There are shelves on the
left hand side, between workstation four and five.
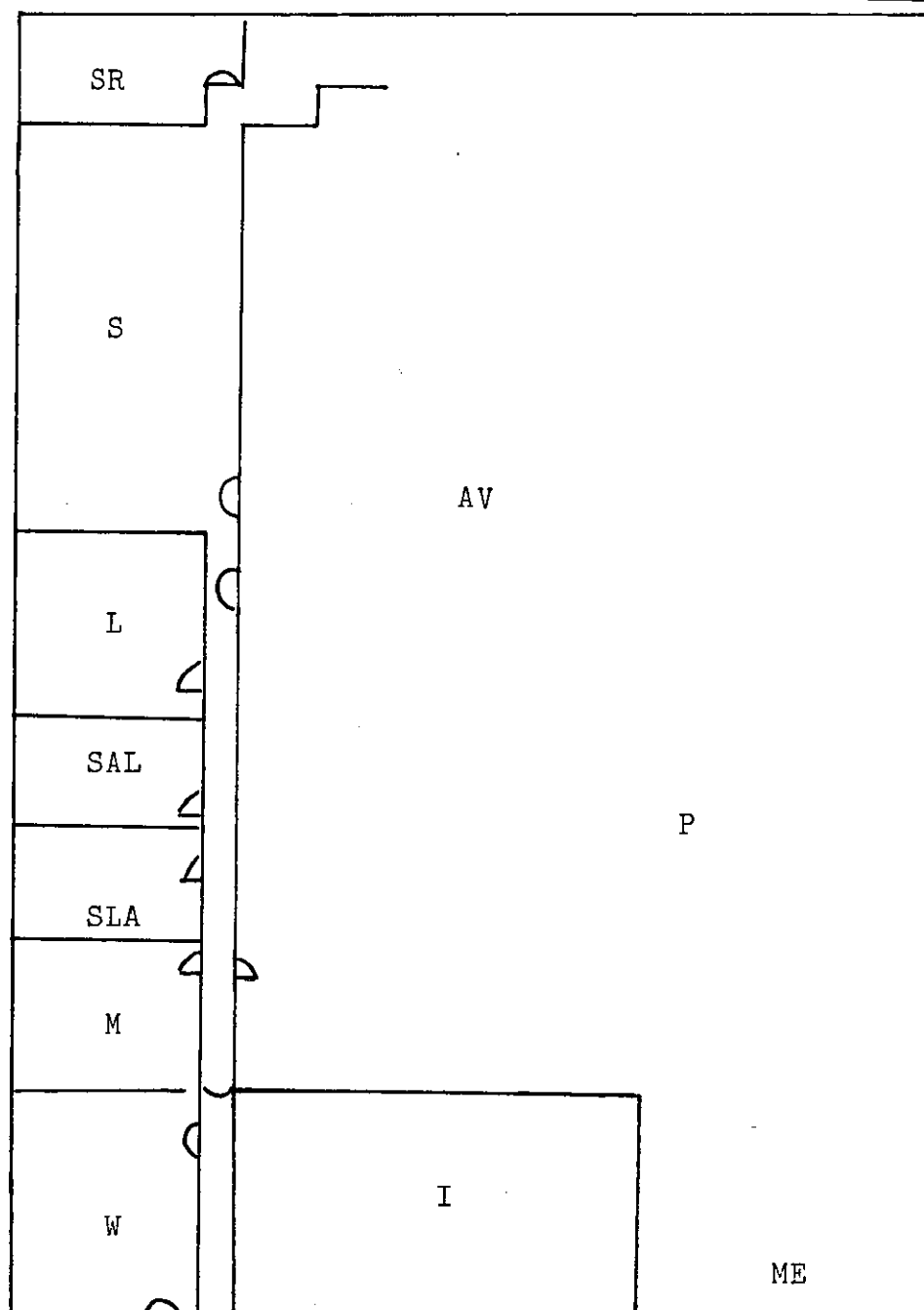
Key: AV = audio visual, I = issue desk, L = Librarian,
ME = main entrance, M = micro-lab, P = periodicals, W
= workroom, S = secretaries office, SAL = senior
assistant librarian, SLA = senior library assistant,
SR = staff room.

*Figure 4 A simplified floor plan of Charing Cross
Medical School Library and Information Service,
showing the location of the micro-lab (not to scale).*
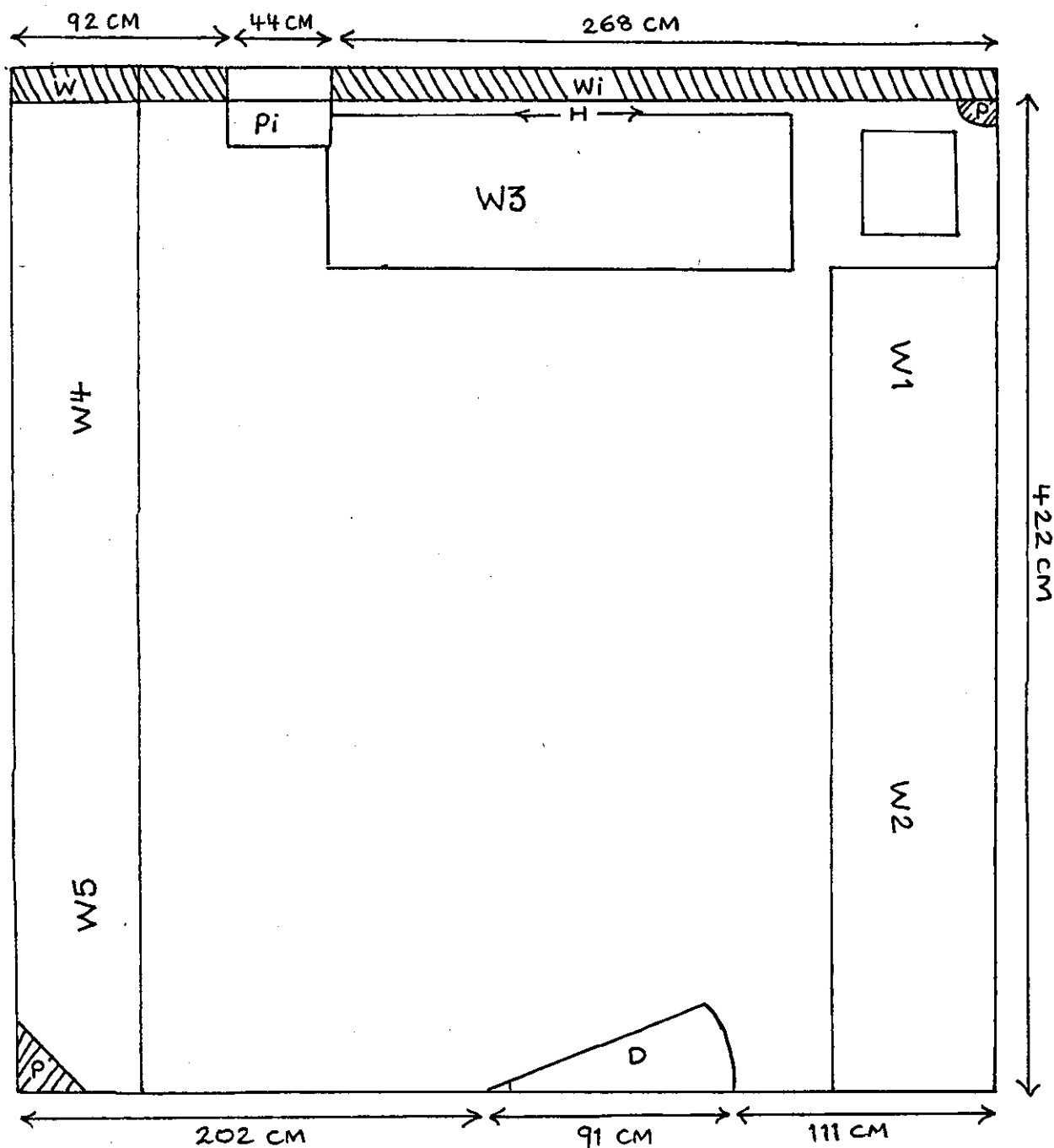
Key: D = Door, H = Heater, L = Lights, P = Pipes, Pi = Pillar, W = Workstation, Wi = Window

Figure 5 Plan of the micro-lab

70

5.1.2.2 Actual Equipment Considerations.

Charing Cross have aquired two Tandon Target 20 micro-computers with two Philips CM 100 disk drive and an Epson X80 dot matrix printer. One of the Philips CM 100's was upgraded to a four drive Hitachi model. In 1988 an IBM micro-computer was purchased with an external Hitachi CD-drive. An Apple Macintosh computer was added in 1989 when Charing Cross were asked to act as a test site for the new MACSPIRS CD-ROM software. In May 1990 a CD-Plus computer was loaned to Charing Cross for four months in order to evaluate the new CD-Plus software being introduced into the United Kingdom. The CD-Plus machine is part of a turnkey package, included in a 386 machine with two integral CD-ROM Drives. Each workstation has an integral hard disc, a diary and compact discs. Manuals are provided.

Since August 1987 workstations one and two have been equiped with Cambridge Scientific Abstracts and the Medline database - Compact Cambridge (CSA). A full service was available from January 1988. They cover the years 1966 to May 1990. Workstation three and four were equiped with Medline SilverPlatter and SilverPlatter Mac Beta Software in February 1989 which came for a trial period in January 1988 and February

1989 respectfully – and stayed! They cover the years from 1983 to May 1990. The Science Citation Index, from 1986-1990, arrived in January 1988. CINAHL, CANCER CD was acquired in 1990, COMPACT LIBRARY AIDS and the OXFORD TEXTBOOK OF MEDICINE is available at workstation three. CD Plus Evaluation was lent for a short period between May and July 1990. The next part sets out the method of research before discussing and evaluating the findings in Chapter 6.

5.2 Method of Research.

The research at Charing Cross and Westminster Medical School Library and Information Service was carried out in June 1990 for a three week period. Every effort was made to make sure the field work was carried out with minimum inconvenience and disruption to library staff.

The results had to be reliable, objective, valid and accurate. The field work involved structured interviews with users and library staff. Supplementary research was also carried out to obtain background information and additional factual information on the micro-lab's design. The method of research is discussed below.

5.2.1 The Interview Survey.

The structured interview technique was designed to obtain the views of library staff and users on a wide range of issues related to human factor problems in the micro-lab. (See Appendix 2). The decision to perform an interview rather than questionnaire was taken for several reasons. Firstly, the responses could be easily investigated, developed and clarified. Secondly, by building up a rapport, the interviewees would remain interested and responsive. Bell offers this anecdote to those who feel interviews are biased. She says that the interview technique is a subjective method of obtaining results but adds,

> '...the interview can yield rich material and can often put flesh on the bones of questionnaire responses' (5).

Discussions with Charing Cross Medical School Library staff identified the most important areas in need of investigation. A number of published interview and questionnaire schemes helped determine the sort of research that had been carried out in libraries in the past. The most helpful work had been conducted by Oxfordshire County Council/NALGO (6), Karim (7) and

Barnacle (8). With a specific hypothesis in mind, the questions were devised.

The interview schedule was piloted to establish how long it took to complete. It also helped ascertain whether the questions provoked enlightened and spontaneous replies. The interview questions were checked by the project supervisor and management staff at the Charing Cross and Westminster Medical Library School who made sure the questions were applicable, relevant, concise, clear, unambiguous and correctly worded (i.e. not biased). It was important the interview should be comprehensive but precise so that it could be conducted in the shortest possible time. The interviews took place at the terminals and lasted ten minutes. Each respondent was asssured that the questionnaires were confidential. Since the respondents saw the interview questions, the interview questionnaire was typed and all the instructions were clearly visible.

The final interview schedule can be found in Appendix 2. It was divided into six parts and was arranged so that the easy and straighforward questions were at the beginning and the personal and sensitive questions were at the end.

Part one, question one to question three, established what user group the respondent belonged to and the demands they placed upon the micro-lab. Questions' four to question six established which workstaion the interviewees were working at, which he/she preferred to work at and why. It was important to ask the respondents which workstation they were working at, at the time of the interview, because it had an impact on their responses in the remainder of the questionnaire. Question seven to question nine were designed to establish the general reaction to the micro-lab and CD-ROM product. Finally, question ten was included to establish whether the interviewee felt there was a need to extend the existing facilities.

Part two, (automation), asked more specifically about problems experienced with the terminals in the micro-lab. The space for comments allowed respondents to put forward additional information. This was very useful when the final evaluation was made.

Part three, (workplace design), established user attitudes towards space in the micro-lab and the seating. Question three was an open question which allowed respondents to say how they would like the micro-lab to be improved.

75

Part four dealt with environmental problems such as lighting and the thermal conditions.

Part five examined whether or not there was a connection between poor health and workplace design. A question which established the association between stress and the work carried out in the micro-lab was included. Again, an open question provided space for additional comments.

Part six established the general attitude towards training and the physical features of the micro-lab.

5.2.2 Specifications.

As well as the interview a comprehensive list of specifications were devised and compared to the facilities that were available. Suitable and appropriate comments were also noted down for future reference. The list of specifications can be found in Appendix 1.

5.2.3 Observation.

A period of observation provided an opportunity to observe the use made of the micro-lab. A task analysis was undertaken at each workstation. This assessed the

category of work, the sequence of events and use made of the facilities.

5.2.4 Photographs.

A number of photographs of the micro-lab were taken to include in the final report. It was felt that this technique would enable the reader to visualize the workstation.

5.3 Limitations of the Research.

The micro-lab was very quiet during the research period which hindered the time it took to complete the investigations. Also, due to the nature of the project, it was only possible to interview people who had time to spare. Consequently not all users of the micro-lab were interviewed and the sample was relatively small-33 completed interviews. Of these, 21% were using the micro-lab for the first time. With hindsight it would have been interesting to discover whether operators preferred to have new, ergonomically designed benching or an extra computer terminal and/or new software. Finally, the equipment in the micro-lab changed as the study progressed which hindered the research objectives. The following chapter evaluates the results of the research.

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CHAPTER SIX

Evaluation and Discussion

This chapter discusses and evaluates the qestionnaire and brings together the results of the observations and measurements taken.

6.1 Personal Details.

The group of people interviewed consisted of 54% females and 46% males. Table 5 shows that one third belonged to the user group 'undergraduate' and one third belonged to the user group 'other'. The group 'other' included research and teaching staff.

User Group	Number	%
Hospital staff	7	21
Nursing staff	1	3
Paramedical staff	1	3
Postgraduate student	2	7
Undergraduate student	11	33
Other	11	33

Table 5: Breakdown of users.

6.2 Frequency of Use and Attitude Profile.

6.2.1 Frequency of Use.

It can been seen from Table 6, that 37% (12), of the people that were interviewed, had used the microlab for 'less than six months'. Of these, nearly half (5) were first time users. Those people who had used the microlab for more than two years (22% of the respondents) tended to be library staff or employees of the Charing Cross and Westminster Hospital.

Time Scale	No.	%
Less than six months	12	37%
Six months to less than one year	7	21%
One year to less than eighteen months	4	12%
Eighteen months to less than two years	1	3%
More than two years	9	22%

Table 6; Length of time interviewees

had been using the micro-lab.

Table 7 illustrates that most people visited the microlab monthly (39%). Of these, six out of the thirteen people (42%) were undergraduates; two were hospital staff (14%); two were nursing staff

80

(14%); two were postgraduates (14%); one was a paramedical (8%) and one person belonged to the group 'other' (8%). (The group other consisted of research staff and nurses who did not fit into the alternative groups) Twenty four per cent (8) of those that were interviewed used the microlab weekly. Of these, three were hospital staff (37%); three undergraduates (37%) and two people (27%) were identified as 'other'. No members of the nursing staff, paramedical staff or postgraduate staff, that were interviewed, used the microlab weekly. Thirty seven per cent of interviewees used the facilities on a 'daily' basis and most of these belonged to the user group 'other'. Hospital staff (two out of the twelve people) and undergraduates (two out of the twelve people) also placed relatively high demands on the microlab on a daily basis.

Usage	Number of people	%
Daily	12	37%
Weekly	8	24%
Monthly	13	39%

Table 7, frequency of use.

81

Although these interviews show that the micro-lab is well used and very popular with undergraduates and hospital staff, some questions still remain unanswered. Like, for instance; When was the most popular time for usage?; How many hours at a time were the workstations used? and What software is logged? All the answers to these questions will have an impact on the setting up of future facilities and the extension of the present. The research and collection of these statistics will also reveal the library's market and potential market which could be targeted during any further expansion programmes. These are obviously future research topics.

6.2.2   Attitude Profile.

6.2.2.1 Attitudes Towards Automation.

In response to the question, "How would you rate your feelings and attitudes generally to automation and computers in libraries?", over three quarters said that they were very positive and under one quarter (22%) said that they were fairly positive. Nobody said they felt indifferently or that they felt negatively about automation in libraries. One person remarked that they thought automation was excellent because "it (the CD ROM's) saves so much time - especially for

students". Somebody else observed that searching was "far quicker and search terms could be more easily mixed to create a unique search strategy using CD ROM which could not be done effectively by using hard copy sources alone". This person had a limited amount of time in which she could search for articles. The user felt that with the quicker CD ROM system she had carried out a more comprehensive search in a relatively short ammount of time. This would not have been possible, she thought, if she had "rushed in and fumbled through Index Medicus".

6.2.2.2 Attitudes Towards the Micro-lab.

When asked to indicate which phrase they agreed with the most with regards the microlab, 91% said they thought that it was a 'good idea'; 39% said that it would "improve the library's prestige"; 84% of the respondents said that it was an "important facility" and 63% said that it "improved facilities in the library". Nobody said that "they did not care" or that the microlab was "not needed".

When asked "How do you think your colleagues react to the microlab and CD ROM?", 61% said that they felt that their colleagues were "very positive"; 24% said that their colleagues were "fairly positive" and 15%

said that they felt that their colleagues were "indifferent". Again, nobody felt that their colleagues reacted to the micro-lab negatively. Several people did remark, however, that they found it hard to answer this question because many of their colleagues were not aware that the micro-lab existed.

In response to the question, "In your opinion, should the facilities in the microlab be extended, kept the same or reduced?", three quarters said they felt that the facilities should be extended. However, one quarter said they felt that they should be kept the same. A few people remarked that because a lot of people did not know about the availability of the CD ROM's in the micro-lab, they saw no need for an extension of the library's facilities. Others said that if more people were informed about it, then the micro-lab would need to be extended!

6.2.2.3 Workstation Preferences.

It can be seen from Table 8, that those individuals who said they had used other workstations in the microlab before, over half (57%) said they had used workstation number one. When asked which workstation they preferred to use; one quarter said their favourite was workstation one. The reasons for this

84

were quite clear. They liked Compact Cambridge (CSA) software and the four disc drives attached to workstation one. This allowed users to search four years of CSA at a time. The preference for the four disc drives was clearly demonstrated; even though the same software was available at workstation two, it was not as popular as workstation number one. Users said that this was because there was only one disc drive. The second favourite of the workstations was number three (which 21% preferred). When probed a little further it became clear that this was because they (a) preferred the Medline Silverplatter software on that terminal and (b) preferred the printer which highlighted the search terms they had chosen.

Terminal	Number	%
One	19	57
Two	16	48
Three	15	45
Four	10	30
Five	8	24

Table 8: Workstation preferences.

People made their preferences on the basis of the type of software at the workstation and/or because they had been trained on the terminal. Staff seemed attracted to workstations one and two, both with CSA software, as they had been installed the longest. Hence, the popularity of a workstation also depended on the preferences the library staff showed towards the computers, the software and the accessories. It is not possible to conclude that any of the participants chose a workstation because of the layout of the equipment, the relative comfort of its layout or any environmental factors. It would only be possible to make these conclusions if all the equipment was identical, in a controlled environment, and none of the staff had any pre-conceived preferences as to which computer they preferred to conduct the training programme.

6.2.2.4 Attitudes Towards Library Staff Support.

Thirty four per cent of those that were interviewed, excluding library staff, said that the support they received from staff was adequate. Indeed, 23% felt that support in the micro-lab was 'excellent'. One person commented, "The training and help I have needed have always been so generously given". The 23% who felt that training was poor felt that this was because

they had not received enough training and also because the opportunities to be trained were not advertised. Comments were also made about the absence of posters and manuals which outlined basic search instructions. One person said,

"Sometimes staff are not available. Initially when getting to learn how to use the machines, there were a lot of techniques that I had to learn. It would be helpful if some of these could be summarised and kept available in the room".

6.3   Automation.

6.3.1   Display Screen.

6.3.1.1 Character Size.

Table 9 shows the comparisons between the different display screens. An asterisk indicates a problem which needs to be addressed. There were no problems with regards to character size at any of the terminals. The points of the dot matrix character generation merged sufficiently to produce a sharp and well defined image. Therefore it was easy to distinguish between the letters X and K, O and Q, T and U, S and 5, I and L, U and V, I and 1, O and 0. The screen at

workstation five was particularly clear. Stroke width, and the space between the characters was adequate. The characters were also upright and stable.

Terminal	1	2	3	4	5
Character size					
Character spacing	*				
Character font					
Character stability					
Cursor legibility					
Character definition		*	*	*	
Luminance button	*	*	*		
VDU adjustability	*	*	*	*	*
Glare	*		*		
Printer noise	*	*	*	*	*

Table 9 Comparisons between the display screens.

(Indicates a problem)*

6.3.1.2 Cursor.

It was possible to distinguish the cursor from the other symbols at each of the terminals.

6.3.1.3 Display Screen and Luminance.

At workstations two, three and four the characters were not sharply defined at the maximum luminance. The luminance could be adjusted at each of the terminals but the button was not clearly marked at workstation one, two and three. The luminance control at workstation three is important because of its position in front of the window. Compared to the bright window the screen remains dark and the characters are hard to distinguish.

6.3.1.4 Additional Requirements.

It was only possible to adjust the orientation of the visual display unit (VDU) at workstation two but even then it was an awkward manoeuvre. At no other workstation were users able to adjust the screen's angle on the horizontal axis. At workstations two, three and five the upper edge of the screen was at or below eye height. This effected the optimum work position, referred to in Chapter 3.

6.3.2 Glare.

In response to Part A of the questionnaire (see Appendix 2) which highlighted problems with glare from the VDU, almost one quarter of those interviewed said that they experienced adverse effects from glare at workstation one and three. The plan of the micro-lab in Chapter 5 demonstrates that workstation one is at a right angle to the window and, therefore, catches the glare from the left. Workstation four was subject to similar problems. However, one interviewee did point out that the glare came, not from the window, as it might be expected, but from the white desk which reflected the light upwards. As the respondent pointed out, "The white desk reflects glare but the Mac screen does not". Workstation three is directly in front of the same window and, when the curtains were not closed, the characters on the screen were hard to read. Similar research in the micro-lab revealed that the absence of a light shield on each of the VDU's and the absence of good vertical blinds at the window emphasized these problems.

6.3.3 Noise From The Printer/VDU.

Noise from all the printers concerned over half of the users that were interviewed (54%). It is

interesting to note that the period in which people declared they had no problems with noise from the printer was when there were few people in the room and so the printers were not in use. Five respondents felt that noise from the cooler fan in the VDU exasperated the problem of noise in the micro-lab. These results must be studied in conjunction with the observations discussed in part 5.5, general noise.

6.3.4 Heat From The Video Display Unit.

Most people said that they felt no ill effects of heat from the VDU. One respondent did remark, however, that heat emitted from the computers added to the problem of high temperatures and poor ventilation in the room (See 5.2).

6.3.5 Computer Breakdown.

The only problems that were recorded in terms of computer failure/breakdown were those at workstation one and two where, occasionally, respondents found the screen blanked or crashed on a search. During the period of observation, none of computers were out of action. To conclude, the computers were kept in good working order and regularly maintained.

6.3.6 Keyboard.

Table 10 shows the comparisons between the different keyboards. An asterisk indicates a problem which needs to be addressed.

Terminal	1	2	3	4	5
Keyboard stability		*			
Keyboard thickness			*		*
Keyboard feedback				*	
Keyboard size					
Function keys	*	*	*	*	*
Angle of keyboard					
keyboard reflection					
Hand rest		*	*	*	*

Table 10 Comparisons between the different keyboards.

(* Indicates a problem)

6.3.6.1 Ease of Use.

Question one asked the user whether or not they found the keyboard easy to use. The measurements revealed that the distance between the base of the keyboard and the home row of keys at workstation three and five was 25 mm and therefore too thin. Secondly, the

desk was too thick so the distance between the underside of the desk frame and home row keys at workstation three, four and five was 105mm, 130mm, and 125mm respectively. The recommended distance is 60mm. At workstation two, three, four and five there was no space on which to rest the palms of the hands. This could make the user uncomfortable and, in time, cause the arms and wrists to ache.

6.3.6.2 Feedback Signal From The Keys.

Four users (12% of those interviewed) at terminal four reported that the keyboard feedback signal was inadequate and failed to assure them that the keys had been successfully pressed. One person remarked that a manual which explained the function of the keys was not available at workstation four. This criticism could be extended to all the workstations. Contrary to this, another respondent preferred to use the keyboard at workstation number four because "it is so simple, which I like". Indeed the keyboard was simple with very few function keys to understand.

6.3.6.3 Layout of the keys.

Six respondents (18% of those interviewed) pointed out that not all of the keyboards were identical.

Consequently, the function keys had to be re-learnt at each terminal which wasted time and placed greater demands on the library staff. Despite these comments it is difficult to purchase identical keyboards especially when they are bought a year apart. Also each computer takes different programmes which use different function keys. The number and layout of the function keys did not correspond to the sequences with which the task was carried out. That is, many of the keys were unnecessary and complicated the task. Also, the function keys were blocked nor distinct from each other, except as part of the standard design. Some sort of emphasis would have helped users identify the most important function keys at each terminal where the software allows. This would also make the computer more 'user friendly'.

6.3.6.4 Labelling Of The Keys.

Five people (15% of those interviewed) remarked that the function keys were not clearly labelled. This was especially true of the important '#' key. A respondent also added,

94

"If only we thought about keyboard layout more critically there could be some vast improvements. Searches carried out on CD ROM need different key emphasis- people just don't type very fast. The 'qwerty' keyboard layout is totally inappropriate".

None of the respondents reported any problem with the angle of the keyboard to the desk surface, the thickness of the keys, reflection from the keyboard surface or size of the keys.

6.4 Workstation Design.

Table 11 presents the measurements that were taken at
each of the workstations. Please note the differences
between the preferred measurement, in box two, to the
actual measurement in columns two to five.

Measurement	Preferred	Workstation no.				
		1	2	3	4	5
Length of the desk	120-160	102	102	80	100	100
Depth of the desk	90-115	76	76	70	59	59
Screen to edge/desk	50-75	34	36	34	34	18
Keyboard to edge/desk	10-26	08	08	10	18	02
Screen above floor	90-115	98	98	111	113	105
keyboard height	70-80	80	80	76	92	92

Table 11   Measurements taken at each workstation
(in centimetres)

6.4.1 Workspace.

It is clear that the length of the desk, depth of the
desk and the distance of the screen to the table edge
was inadequate at each of the workstations.   The

desk at workstation four and five was too high (see Plate 4 and 5) which meant that operators were looking up at the screen and not sitting in the optimum position described in Chapter 3. All users interviewed at workstation one (twelve people) felt that the length of the desk was adequate and 58% (five out of twelve respondents) also felt that the leg/knee clearance room and the area underneath it was 'good'. Also, 58% (seven out of twelve interviewed) at workstation one felt that the space on the desk was adequate. These points are demonstrated in Plate 1.

Plate 1 Workstation Number One.

Users at workstation two felt that the length of the desk, width of the desk, area underneath the desk, leg/knee clearance was adequate. So too was the access to and from the desk. However, 71% (five people out of seven) said that the width of the desk and, subsequently, the space on the desk, was poor. These points are illustrated by Plate 2. Note how the desks are full of hardware, leaving very little room to place personal documents, or re-arrange the desk to meet personal requirements.
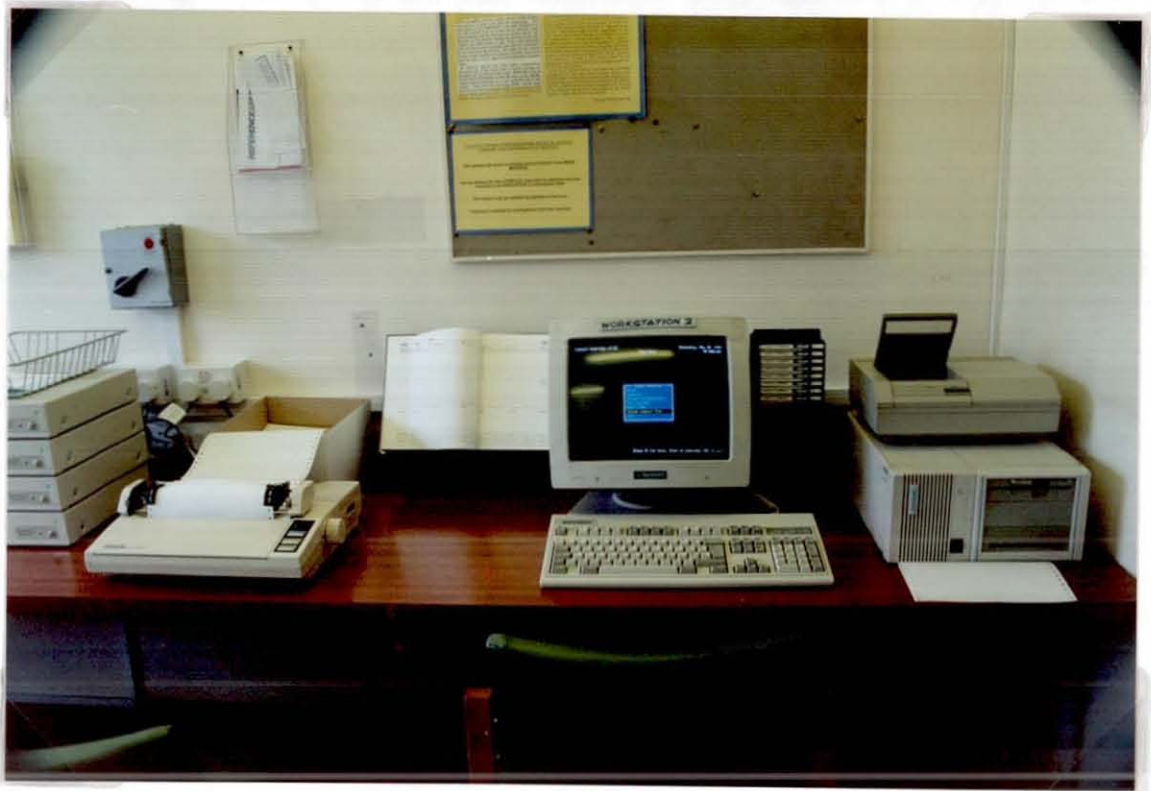
Plate 2 Workstation Number Two.

The respondents at workstation three said that space at the desk and access to and from the desk was poor (five out of the nine that were interviewed). One respondent echoed other people's feelings when he said, "there is no room for the print paper to go and sometimes it gets clogged up and can feed back into the printer". These points are demonstrated in Plate 3.
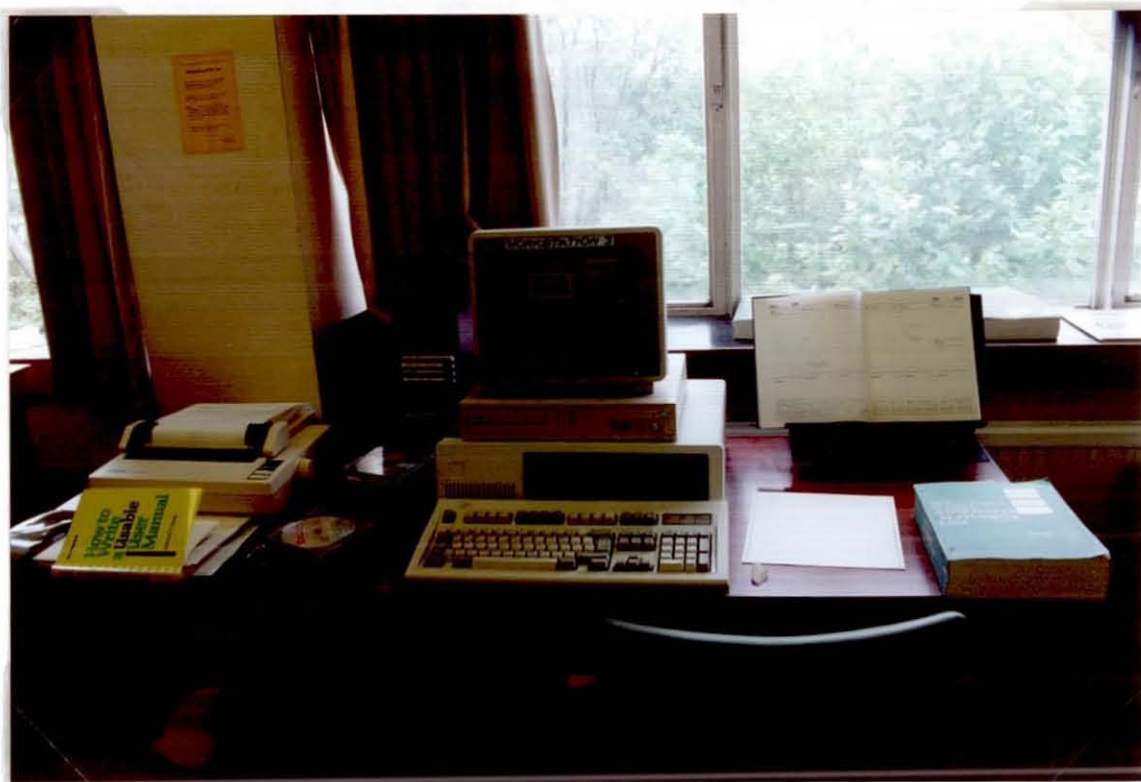
Plate 3 Workstation Number Three.

Sixty per cent of the respondents at workstation four
(three out of the five people interviewed) felt that
the space available on the desk, the length and width
of the workstation, leg/knee clearance and access to
and from the desk was poor. There was no space for
users to put their documents when they were word
processing. Plate 4 illustrates how the table leg
limits access to the workstation. Also, the
workstation was congested.

Plate 4 Workstation Number Four.

The interviewees who had worked at workstation five were unhappy with the availability of space on the desk and the width of the desk. Plate 5 shows that the cupboard to the right of the terminal limitsaccess and movement. It also illustrates how the desk is cluttered and the lack of room at the front of the desk for the user to rest her palms.

Plate 5 Workstation Number Five.

6.4.2 Distance Between Workstations.

Over two thirds of the interviewees felt that the distance between the terminals was 'too crowded'. One third felt that the distance between the terminals was 'adequate'. Nobody said that the terminals were 'too isolated'.

At workstation one, three quarters (nine out of the twelve interviewed) complained that there was not enough room between terminals. One respondent said that, because of the close proximity of workstation three, the room was too cluttered.

At workstation two, nearly two thirds (four out of the seven interviewed) said that the terminal was too close to the other terminals. This terminal is next to the door. It is possible that the continuous movement of people distracted users and disturbed their concentration.

At workstation three, all but one person (88%) said there was insufficient space between the terminals. One respondent said that "The problem of distance between terminals is more acute when all the workstations are in use". The respondent also added "I try to organise my day so that I arrive at 9:00 am in

the morning when the lab is less busy and not so noisy". Another respondent said, "This workstation seems to be hemmed in on both sides. The printer is almost out of reach". The questionnaire confirmed that workstation three was too close to workstation one and four. The problem was most acute when training programmes were in progress when at least two people were sat in front of a terminal. If the training programmes are extended and lecturers are encouraged to train their own students, the shortage of space in the micro-lab will be even more noticeable.

At workstation four, 75% of the respondents (three out of four people) said that it was too crowded. Some people said it was only possible to get to the printer by squeezing between the desk at workstation three and the desk at workstation four.

Workstation five was well positioned. It was out of the way of people entering the lab and ralatively well placed in a quiet corner with few obstacles.

6.4.3 Job Aids and Other Items of Equipment.

It is important that standard equipment (printer, CD's, manual, disc holder, keyboard and screen) is positioned so that the user can maintain an optimum

103

working posture. However, in the micro-lab, there was no space provided for handbooks, documents or personal belongings. Neither was the equipment arranged according to frequency or sequence of use, function or importance. Due to the lack of space on the worksurface, the users were not able to rearrange the workplace according to their requirements. Hence, the workstations did not accommodate both left handed and right handed people, people with disabilities, or even people with documentation to use in conjunction with the terminal.

The inclusion of foot rests and copy holders (excluding those that carried the diaries) would have been useful additional items of equipment. Footrests were necessary at workstation four and five because the bench was too high and the legs of a user were not supported. Hence, users were unable to adopt the optimum working posture. Copy holders would have taken the clutter from the desk.

6.4.4 Seating.

Most of the problems concerning the seating at workstation one, two and three was a result of the seats not being adjustable. (The design of the seat was the same at workstation one, two and three) Plate

6 reveals that the seat was not provided with castors and the backrest and seat height could not be adjusted. The seat was neither mobile or flexible and so could not be altered to meet personal requirements. Neither did the chair meet national safety standards for working at a computer terminal. This point is illustrated in Table 12 below. Please note that the 'optimum' measurement relates to the national safety standard.

| | | Seat No. | | | | |
Measurement	Optimum	1	2	3	4	5
Backrest:						
Seat Surface to top	48-50	34	34	34	41	37
Width of backrest	32-36	47	47	47	34	35
Lumber Pad:						
Distance above/seat	10-21	17	17	17	12	11
Seat: Width	40-45	50	50	50	41	42
Length	38-42	44	44	44	39	39

Table 12 Measurements taken of each chair.

(In centimetres)

The users interviewed at workstations one, two and
three also felt that the backrest, backrest
adjustability and seat height adjustability was poor.
Indeed at workstation three, the seat was so low,
users had to look up, rather than down, at the screen.
This point is illustrated in Plate 1 on page 97.

Plate 6: Seat Number One.

The seats at workstation four and five were adjustable so most people were happy with the height and back rest adjustability. (See Plate 7 and 8) Unfortunately there were no guidelines on how to make these alterations and the adjustments could not be made from the seated position. Even in a standing position the adjustments were difficult to make. Those people at workstation four and five were largely unaware that alterations could be made. Signs explaining this would be a useful addition to the 'user friendliness' of the micro-lab. The back rest of the seats at workstation four and five did not meet the national safety requirements. Finally, at workstation four and five the bench was so high above the floor, that when seated, the user could not touch the floor and the users legs were not horizontal. Hence, the user was not able to sit in the optimun sitting position. New seats and footrests were needed.

6.4.5 Workstation as a Whole.

When asked to rate the workstation 'as a whole', nobody felt that the physical features of the workstation were 'good'. Indeed a majority (69%) felt that it was 'adequate' but that improvements could be made. For instance, one interviewee pointed out that, "the width of the desk is too thin, therefore there is

no flexiblity". Another respondent said that they "had plenty of space and access, (i.e. leg clearence room) but that the seating and space on the desk was poor". Similarly, a third respondent said, "the workstation is poor because the desks are too high and there is no space for my work. Also the chairs are inflexible and too low for comfort". Some said that the workstation could be better designed and that the lack of space made note-taking almost impossible. Indeed, because of the lack of space, several people put their working documents on a second chair.

6.4.6 Overall Performance.

Of those interviewed, 52% felt their job performance was effected by the problems of the design of the workstation. One respondent felt that their performance deteriorated "the longer I spend at the terminal". Another noted, "Working for long periods of time can be uncomfortable — the lack of space is uncomfortable even for quick visits,". Most worrying was this comment from a regular user who said, "The inadequacy of the workstation's design makes me want to get away quicker, thus limiting my search".

Plate 7: Seat Number Four.

Plate 8: Seat Number Five.

6.5. Health and Safety.

6.5.1 Muscular Complaints.

Table 13 shows that over a third of the people that were interviewed had suffered from general tiredness and headaches in the past six months. Of the two people that said that they had suffered from cramps as a result of working at the VDU, one said they had suffered cramps in the neck and both said that they suffered from cramps in the shoulders and lower back.

Problem	number	%
General tiredness	12	36
Headaches	13	39
Dizziness	--	--
Fainting	--	--
Cramps	01	3
Other	04	12

Table 13 Health related complaints.

There was a more negative response when respondents were asked how comfortable or uncomfortable their work posture was in different areas of their body at the

time of the interview. The responses have been summarized in Table 14.

Feature	Response		
	Comfortable	Adequate	Uncomfortable
Neck	2	20	11
Shoulder	4	23	04
Arms	12	21	--
Hands or Wrist	12	21	--
Upper back	5	13	15
Lower Back	5	13	15

Table 14 Physical discomfort.

Most people who expressed a problem experienced discomfort in their upper and lower back. At workstation one, seven out of 12 said their upper back was uncomfortable; four out of seven people interviewed referred to discomfort in their upper back at workstation two and three out of five people said their upper back was uncomfortable at workstation four. Most people who said their lower back was uncomfortable were seated at terminal two, three and four.

6.5.2 Visual Complaints.

Of the 39% interviewed who said they wore spectacles or contact lenses at work, approximately one third said that they experienced problems at the VDUs in the micro-lab. Several people who wore contact lenses mentioned that their eyes dried up at the screen very quickly because their eyes stayed in one position for a considerable length of time. This problem could be avoided if a picture or poster was fixed to the wall so that, during rest periods, they could focus their eyes on this rather than on the screen. Others mentioned the problem of 'double glare' generated from both the screen as well as from their spectacles which was made worse because of the absence of good blinds and anti-glare screens on the VDU's. Most of these problems were experienced at workstations one, two and three.

6.5.3 Stress.

When asked "How would you describe your work in the micro lab; often stressful, sometimes stressful, or never stressful", the majority (67%) said they found working at the workstation "sometimes stressful".

The effects of having a limited period of time to search in, and the lack of confidence in their search strategy greatly effected the amount of stress they felt. One operator related the stress she felt to the lack of time she had. She commented that she felt the most, "When the machines are all in use. That is when it is stressful". Others complained that the computers were often busy when they wanted to use them which was frustrating, especially when they just wanted to carry out a quick search.

Operators also highlighted the fact that they were irregular users and not completely familiar with the software or the equipment. They felt there was not enough help. For instance, there were no signs on the walls explaining the function keys or telling users the steps to take in making a strategy. Indeed the MeSH terms were not properly explained. There was no indication that training sessions were available or which library staff would be able to help them if they had a problem. Also, although the service was not formally available, there were no instructions on how to use the Apple Macintosh as a word processor. One user said, 'I have not been able to find what I want using my search strategy'.

Another person remarked that she had only used the machines a few times before and she was worried that she was going to "blow them up". The fear of ruining the machines is real and there is a need for signs which offer Help and also include which librarians will offer advice and training. Finally, one respondent said,

"I find the lack of results stressful. That is, I always have a lot of print-outs when I have finished my search but I can hardly find any of the articles in the library. I think the computer should have the facility to say if an article is in the library".

6.5.4 Cabling and Other Problems.

The cabling was obtrusive. Although the cables were run at the back of the desk they were not labelled or fixed to the wall. It would have been quite easy for a client to accidentaly pull a wire with his/her feet and consequently move the computer, or to pull a wire out unintentionally. These points are illustrated in Plates 1 to 5. In the future, cabling needs to be carefully planned, labelled, fixed and protected. Rather than a full carpet, carpet squares would also enable easy access for improvements if and when they

take place. The relevance of this is best explained
by recounting an experience encountered by a theatre
in Manchester. New computers were being installed in
the box office but unfortunately, the old cabling ran
underneath the old carpet. Rather than just take up
the relevant section, the whole carpet had to be
removed and replaced. This disturbed the whole
office rather than limiting the disruption to a small
section.

The voltage supply to the VDU system had not been
stabilised against fluctuation in supply. This meant
that the computers could blow up in extreme
circumstances, such as an electric storm. Finally, the
computers were not fitted with alarms and could easily
be stolen.

Those respondents who had further comments to make
about the health and safety aspects of the micro-lab,
said they wanted to see more information on health
and safety issues. One respondent said, "A self help
guide to looking after yourself at a VDU screen would
be an idea". This could include instructions on when
to take breaks, correct sitting posture, how to avoid
glare etc. It was noted that the screens were not
cleaned, only dusted.

6.6 Environmental Conditions.

6.6.1 Lighting.

Three quarters of those interviewed considered that the light in the workroom was adequate. Those people that experienced problems, did so because the light was too bright rather than too dark. Often the responses depended on the weather. For instance, when it was a sunny day, users complained about the glare from the window on the VDU screens at workstations one, three and four, particularly in the morning, when the curtain was not closed.

The problems at workstation three were more unique. As a result of the screen being directly in front of the window, it was hard to distinguish between the characters. A few people did use their initiative and closed the curtains. Unfortunately they often forgot to switch the lights on and the micro-lab became quite dark. This is illustrated by Plate 3. Note how the screen is dark against a very bright background and also that the eye has to constantly readjust to the bright light at the window to the dark screen and bright source document.

Workstations two and five were placed further away from the light source and were away from the direct glare of the sunlight. The terminal at workstation five was fitted with a flat, rather than concave screen, which did not reflect the light.

The problem of glare on the screen, and even of the high temperatures, could be controlled with the introduction of horizontal blinds at the window. Shields, placed in front of the screens would also prevent the worst aspects of the glare. In order to control the lighting, in an ideal situation, two/three phased lighting would be useful and/or daylight equivalent ambient lighting.

6.6.2 Temperature.

Table 15 shows nearly half of those interviewed found the micro-lab too hot. Most of these people found that the heat was most disturbing in the morning when the sun shone through the windows. High temperatures could, to a certain extent, be controlled by opening the windows. However, on a windy day, draughts would lift paper off the tables at workstation two, three and four. Also, noise from the street disturbed users in the micro-lab. A simple solution to this problem would be the installation of a fan. Attention would

need to be paid to the noise levels of the selected item.

Response	Number of people	%
Too hot	16	47%
Adequate	16	47%
Too cold	01	4%

Table 15 Subjective responses regarding temperatures.

6.6.3 Air Circulation.

Taken in conjunction with temperature, 39% felt that the air circulation was too still. Obviously this would depend on whether or not the windows were open.

6.6.4 Humidity.

Of those that felt that the humidity was inadequate, approximately one quarter complained that the atmosphere was too dry rather than too moist. A few people commented that they found that they had to drink more water after they had worked in the micro-lab. A few plants in the micro-lab would solve this

problem and also brighten the room up-provided there
was time to water and care for them!

6.6.5 Noise.

One of the interviewees commented, "When all the
printers are in action - it's awful!" Indeed, table 6
shows that two thirds said that they found either the
noise from the printers or people in the lab, or both,
too noisy. One person who had just been introduced to
the CD-ROM and undergone a training session said,
"While training, there were two printers going and a
man tutting at the next terminal. I found it very hard
to concentrate while I was being trained". Another
person exclaimed, "oh! the printers!!" An alternative
would be to place the training computer in another
room. It would then mean that those being trained
would not be disturbed by the printers and those using
the micro-lab would not be disturbed by the training
sessions.

Noise could be reduced with the purchase of acoustic
hoods which can be fitted to the printers and reduce
the noise levels. However, they can be more of a
problem than the noise. This is especially the case if
they have to be removed after each printout. In the

future silent printers, now on the market, should be bought.

Response	No. of people	%
Too noisy	21	64%
Adequate	12	36%
Too quiet	--	--

Table 16 Subjective responses regarding noise.

6.7 Summary.

Although most people were "fairly happy" with the physical features of the micro lab, over one quarter of the people that were interviewed did say that they were "fairly unhappy". Of the people that were interviewed, the areas of concern were; glare from the window and desk; noise in the micro-lab, especially from the printers, training sessions and outside, when the windows were open.

In terms of the automated equipment, operators were concerned with the feedback signal from the keyboard; layout of the keys; labelling of the keys and the lack of uniformity of the keyboards in the micro-lab.

121

Respondents were very unhappy about the lack of space in the room. The benching was not wide or long enough so the desks were cluttered with hardware, compact discs and documentation. The seats were also wholly inadequate. There was also poor ventilation. It was difficult to open the windows to create air movement without papers moving.

People were concerned that the lab was too busy, especially if they wanted to carry out a quick search. They also wanted to be able to read more 'Help!' signs that informed them about health and safety issues, who to contact when they had any problems and simple instruction about how to arrange search strategies and what the function keys did.

When they were asked to say what they thought needed to be improved most paid special attention to better benching; new chairs; vertical blinds; quieter printers; improved ventilation; partitions between workstations to reduce noise; extra compact disc drives at all the workstations, similar to workstation one; and above all else, more room! Reference to the availability of training manuals and the the introduction of a training computer in a different room was also mentioned.

The measurements and photographs confirmed these points and, where appropriate have been included in the evaluation. It also highlighted the need for larger desks and more room.

If improvements are to be made to the micro-lab or if the present facilities are to be extended all the points have to be borne in mind. As services are introduced and expanded care must be taken to make sure they are pleasent places to work in. The emphasis on marketing demands professionalism and serious regard to atmospherics. A workplace that acknowledges health and safety standards will reduce the incidence of associated health problems for staff and operators. Searches and work conducted on the word processor will be more productive and operators will be motivated to return. One respondent made some of these points when she said,

"As I use the facilities sporadically the general comfort of the chairs and space are not that important, however, as I become more proficient and nursing demands increase for this service the amount of space at the station, is increasingly important. A more comfortable chair would be an advantage. A blind at the window would be most welcome".

CHAPTER SEVEN

Recommendations And Conclusions

Unfortunately in the real world many constraints exist which prevent librarians from implementing exactly what they would like. Even a librarian whose conscience is raised enough to appreciate the health and safety implications of badly designed furniture, will be hard pressed to carry out improvements if there is no money or any staff time to commit to the project!

Librarians find that they have difficulties keeping up with new technology, products and working dimensions. These difficulties are compounded by the lack of staff experience and the newness of the technology. When given the choice to buy a new computer or new benching it is not surprising that librarians choose the former.

For instance Charing Cross and Westminster Library would be well advised to re-locate the micro-lab, replace the tables and seating with ergonomically designed and purpose built furniture which meets the training and other needs of the micro-lab. However, it is recognised that the aforesaid constraints exist and

that these changes can not be done in the near future.

For this reason the recommendations are divided into short term and long term goals. The latter demands more financial commmitment and forward planning. The recommendations should be used as suggestions on how the micro-lab can be improved. They relate to the specific problems identified at the research stage (interviews with staff and users, observation and measurements). They should not be implemented unless they fit in with the long term library 'plan'.

All the recommendations should be administered in conjunction with Chapter 3 and 4 which discusses the ideal layout of a CD-ROM laboratory in more detail. All the prices quoted were correct at the time of printing.

7.1 Long Term Objectives.

7.1.1 Option One.

Ideally the micro-lab needs to be re-located in a room that is large enough to accommodate 10-15 terminals. This will allow for the expansion of services in response to the demand shown in the questionnaire. It

125

will provide an opportunity to install furniture which allows the operator to adopt the optimum sitting posture. In order to carry this out the library management needs to consider the following programme of action.

* Set up a working party whose objective is to administer the changes and carry out a feasibility study on the possible site(s).

This approach will have the advantage of involving staff in the design of their workstation and, by simulating the workstation, time and money will be saved later on. The feasibility study can be administered in the following way:

* Establish the primary brief which includes:

    a statement of aims:

    items to be included in the design

    task analysis to take account of:

    life of the building,

    flexibility and expansion requirements

    conditions of access

    site limitations

    movement of people

    security

    communication

cost limits

* Conduct the feasibility study:

investigate proposed site(s) by asking questions like:

what are the space relationships?

what are the structural problems related to the physical requirements?

analyse costs

report on the findings

* Develop the secondary brief:

establish the pattern of operations by considering,

communications

movement

furniture

fittings

set out a contract and maintenance policy

visit other libraries and read the available literature!

* Detail design:

Draw up detailed plans to include:

layout, critical sizes

furniture and fittings

floor coverings

lighting

layout of manuals

finishes

* Security. Consider:

    cabling

    alarms on machines

* Physical conditions. Consider:

    climate

    heating

    cooling system

    air conditioning

    ventilation

    noise

* Analyse costs

* Final report

7.1.2 Option Two.

Chapter six shows that the desks are inadequate but they are permanent features and non-adjustable. Consequently, major structural alterations need to take place in the micro-lab.

A less favourable option is to re-design the existing micro-lab. However, there are several disadvantages linked to this proposal. For instance, this option would necessitate a reduction in the number of terminals. This will mean that the micro-lab will not meet the present and on-going training needs. It is also in direct conflict to the views expressed in

the interviews which stressed that the micro-lab should be extended.

(i)   Purchase new desks. The specifications are detailed in Chapter 3. The desks should be flexible so that it can be transported to different sites in the library if and when the micro-lab is re-located.

(ii)   The desks should be placed along the left and right hand side walls, at right angles to the window. However, since this will reduce the space in the room, no more terminals can be added. The new positions are illustrated in Figure 6.

(iii)   The terminal could be removed from in front of the window and positioned at workstation five on the new desk in place of the terminal which is 'on loan' for trial periods. Unfortunately this will mean that there will be fewer terminals in the workstation. This is illustrated in Figure 6.
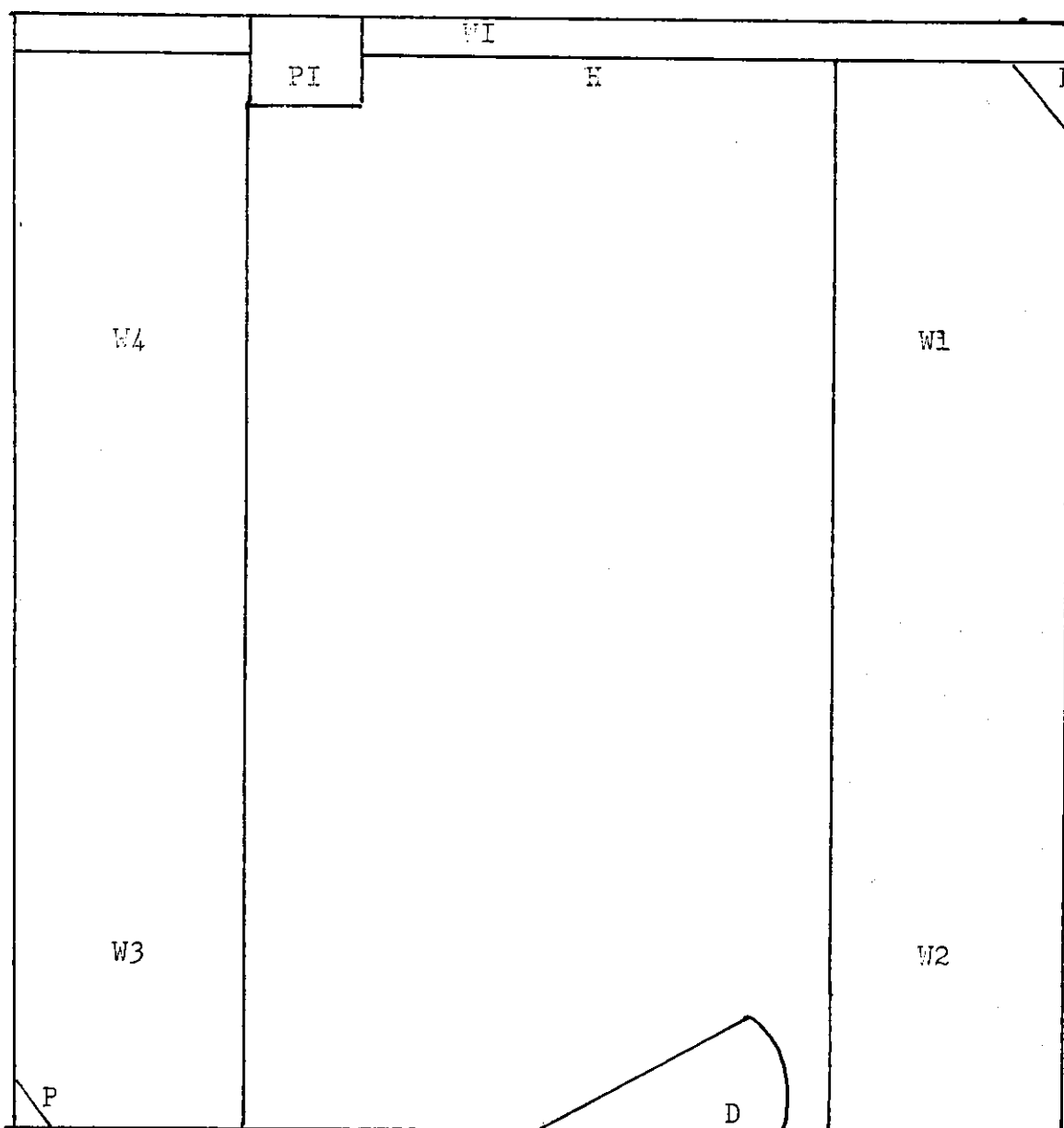
Key: D = door, H = heater, L = lights, P= pipes, PI = pillar, W = workstation, WI = window.

Figure 6 The position of the furniture after the re-design of the micro-lab.

(iv)   The hardware is not consistent and has
        dissimilar features. The library staff could
        formulate a policy statement which outlines
        the hardware requirements so that, when
        computers are purchased in the future, the
        standards will be set and the needs will be
        established. Consequently, future computer
        terminals will all have similar features and
        layout. This policy document could also take
        account of the future and developing needs of
        the library.

(v)   When hardware is replaced the policy document
        could include a list of desirable, luxury and
        unnecessary features. The following facilities
        should be listed as desirable. They are absent
        at the majority of the terminals.

        * Clearly defined adjustment buttons
        * Adjustable vertical/horizontal screen axis
        * Feedback signal on the key return.
        * Uniform layout of the keys
        * Quiet printers that highlight search terms
        * Four disc drives to accompany each terminal.

(vi)   Suppliers could be encouraged to produce
        software that can instruct the operator if the

131

article, cited in the search, is held by the library.

(vii)   The lighting needs to be reviewed. Librarians could consider the position and type of lighting, plugs and cabling. Their objective would be to provide suitable ambient lighting, preferably uplighters with direct lighting for source documents.

(viii)   The cable route needs to be co-ordinated and fixed. The plugs could be labelled so that the link with each terminal is made.   Cable bridges can be bought as single or twin tracks. A 1500 mm single channel bridge costs £20 and a double track costs £25 (1).

(ix)   All future floor coverings should be carpet squares rather than wall to wall carpeting.

7.2 Short Term Objectives.

7.2.1 Workstation Re-design.

The point has been made that the present layout of the furniture, its permanency and the lack of space in the micro-lab means that very little can be done to

improve the layout of equipment to provide more space. For example, there is not enough room for a stacking system which would take the hardware away from the desk. However, a few changes can be administered. All the recommendations are flexible and can be transferred to another location at a later date. Temporary measures to improve the amount of space on the desk can be implemented as follows.

(i)   The terminals could be re-arranged. Workstation five could be replaced with workstation three. Figure 7 illustrates these changes. Unfortunately, the facilities available in the micro-lab will be reduced.

(ii)   Since equipment should be positioned according to frequency of use and sequence of events, correctly placed shelving (above each terminal) would remove the manuals and compact discs from the desk and save space. They would also be within the optimum reach requirements.

        A 'popinjay' is a filing frame with five adjustable dividers which comes in two sizes and can be fixed to the wall or put on a desk. The larger one accommodates software manuals

and the smaller model will hold compact discs. They are available in three bright colours and cost £5.95 or £9.95, depending on size (2). In a larger room a more elaborate storage sytem could be purchased. They offer modular design, a choice of drawer interiors, good protection and easy access. They are, however, expensive and can cost up to £300 (3).

(iii)   A printer stand would raise the printer off the desk and store the paper beneath the printer. Consequently, noise would be reduced and space on the desk would be saved. They can cost from £30 to £40 (4).

(iv)   Adjustable footrests (in height and angle) could be purchased for all the workstations.

(v)   Where the task requires the operator to consult a document, copy holders should accompany the terminal. A good copy holder will have a built on stand for the desk top and a heavy duty extension arm that can be fixed to the terminal. These cost from between £20 to £30 (5).
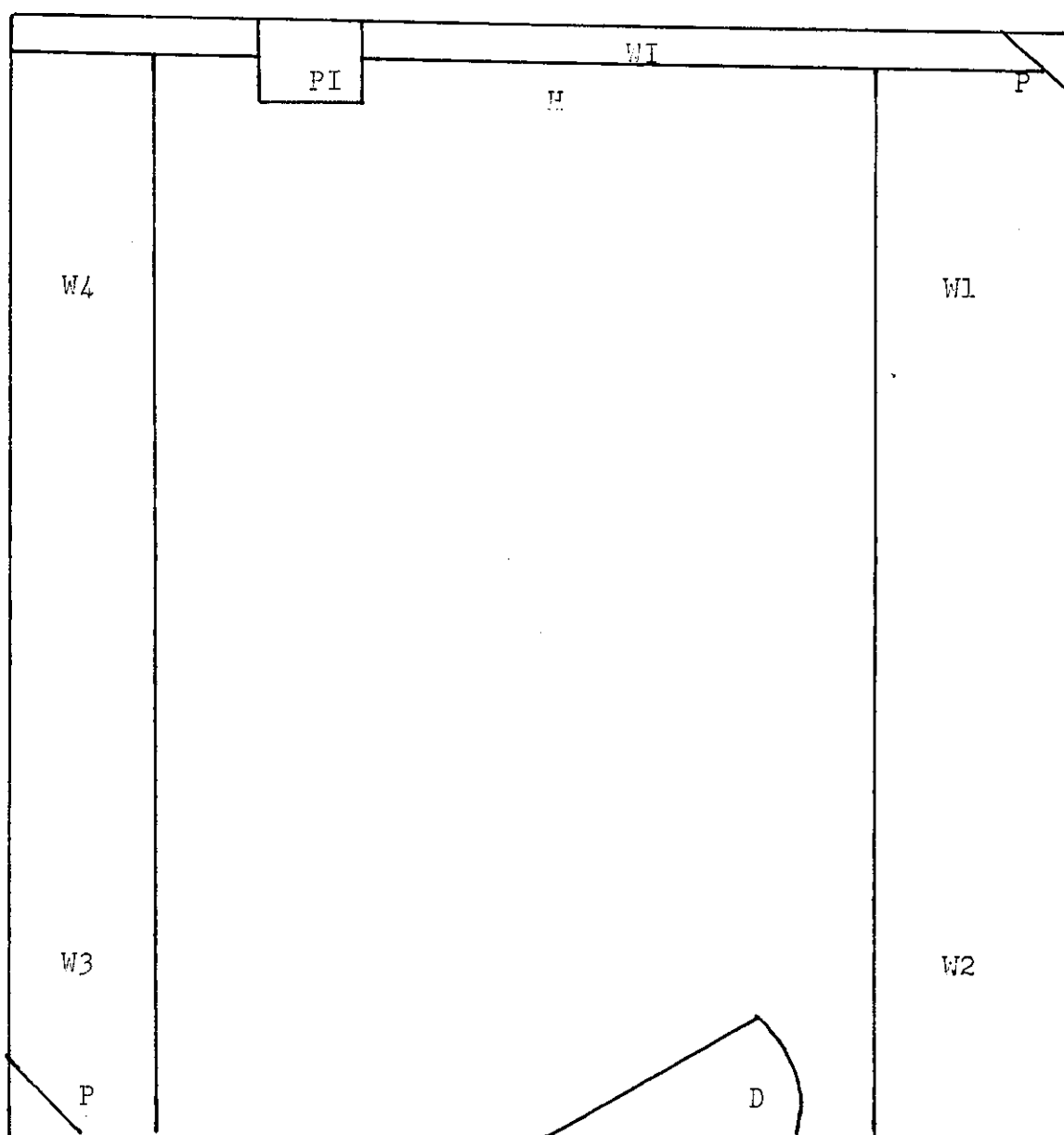
Key: D = door, H = heater, L = lights, P= pipes, PI =
pillar, W = workstation, WI = window.

*Figure 7 The position of the furniture after the re-
design of the micro-lab (keeping original furniture).*

135

(vi)   New seating arrangements will alleviate some
         of the problems with regard poor benching and
         help operators adopt the optimum sitting
         posture. Conventional typists seats or high
         backed chairs, that satisfy ergonomic
         requirements, could be purchased. The seats
         should support the whole body so that disc
         pressure and muscular tension is kept to the
         minimum. The backrest, height, forward,
         upright and leaning positions should be
         adjustable from the seated position. (A gas or
         hydraulic system will be satisfactory) The
         chairs need to be stable with five point
         bases and fitted with castors to aid mobility.
         The seat base should swivel so that the
         operator does not twist. All the chairs
         adjustable mechanisms should be fitted with a
         lock mechanism. Preferably, the chair should
         not be fitted with arm rests as this will
         inhibit movement. Chairs can cost from £90 to
         £500, depending on the style (6).

(vii)   Instructions, informing operators on how to
         make the seat adjustments, should be placed on
         the wall.

7.2.2 Automation.

(i)   The problem of glare on the screens at
        workstation's one and four could be alleviated
        with the provision of anti-glare screen
        filters or treatments. Filters that reduce
        glare by up to 95% cost in the region of £25
        and can be bought for monochrome or colour
        sets (7). They are available in different
        sizes.

(ii)   A more suitable alternative would be the
        provision of adjustable vertical window
        blinds which will block out the early morning
        light rays without reducing the overall
        luminance. Vertical blinds would also control
        the high temperatures in the micro-lab first
        thing in the morning.

(iii)   The purchase of swivel screen stands for each
        computer will enable users to properly adjust
        the screens inclination which will alleviate
        some of the problems of poor benching and
        seating. They cost around £50 (8).

7.2.3 Environmental Solutions.

(i)   The dry atmosphere in the library could be improved with the introduction of plants or humidifiers. Obviously someone would have to be given the responsibility to water them!

(ii)   To improve the overall impression of the micro-lab, it could be painted a green/blue colour. Bright pictures and information boards would also brighten the walls and provide useful information. This will give operators an object on which to focus their eyes. The paint would probably cost £20 and the boards from £30 to £50.

(iii)   To reduce the stress caused by noise, the printers need to be regularly maintained and the cooling fans checked to see that they do not make too much noise. Ninety per cent of the noise can be reduced by placing a rubber pad between the desk surface and the printer. A printer stand and catch basket which raises the printer off the desk and allows the paper to be stored underneath will save space and reduce vibration. They cost between £30 and

£40 (9). In future new printers should be checked to see if they are quiet.

7.2.4 Miscellaneous Solutions.

(i)   It is important that the library carefully monitors who uses the micro-lab, how long they use it for and what software and terminal they prefer to use and why. This will provide the staff with a greater understanding of the use made of the present facilities. It will also provide management statistics which can be used to help formulate management plans. The market and potential market will also be revealed.

(ii)   Outreach and user education is an on-going service provided by staff at Charing Cross library but it could be made more visible. User education should introduce clients to the available services and inform them on how to get the training, how to perform a search on the computers and introduce them, at each terminal, to the function keys and MeSH terms. This will reduce fear and create a much more user friendly environment that attracts and maintains interest.

139

(iii)   It   is   important   that   everybody   in   the workplace   is   made   aware   of   the   need   to consider   the   design   and   proper   layout   of   the furniture   so   that   items   are   not   moved   around without   considering   the   implications.   In   the long   term   this   can   be   implemented   with   the formation of an 'ergonomic working party'.

7.3 Conclusions

This   thesis   has   applied   ergonomics   to   the   work environment   at   Charing   Cross   and   Westminster   library and   formulated   a   series   of   recommendations   as   a result   of   the   research.   Chapter   2   sets   out   why   it   is important   to   examine   ergonomics   in   the   work environment   and   linked   the   human   component   and   legal aspects   to   marketing   and   issues   of   health   and   safety. Chapters   3   and   4   examined   the   requirements   of   a computer   workstation   and   a   CD-ROM   workstation.   It claimed   that,   in   order   to   re-design   the   workstation, a   manager   must   be   made   aware   of   the   equipment   needs, sequence   of   events   and   task   analysis   of   the   workroom. Only   then,   it   argued,   can   a   manager   begin   to   acquire machinery,   re-design   the   workroom   and   replace   the furniture.

The research revealed a deep concern over space in the micro-lab in terms of the layout, storage facilities and space between terminals. Many felt that the lack of room and layout of the furniture caused muscular discomfort and eye strain. The latter problem was also connected to the position of the VDU's in relation to the light source. Noise was also a problem. The results of the interview confirmed and substantiated the observations that took place and the theory that was documented in the first few chapters.

The research also revealed that respondents wanted the facilities to be extended. They especially liked workstation number one because they favoured the software and the four disc drive.

The recommendations were made in the form of long term and short term goals so that they could be implemented when Charing Cross and Westminster Medical Libray and Information Service had time and when the finance was made available.

It is very easy to forget ergonomics when acquiring new and expensive machinery but library managers must remember that many problems connected to automation are preventable if they address ergonomics, workplace design and health and safety issues. Paradoxically

managers are prepared to spend thousands of pounds on automation and relatively little on furniture. If they changed their priorities just a little bit not only will they have a happier and healthier workforce but they will have a growth orientated workspace that attracts and keeps clients.

7.4 Further Study

There is little written about the human effects of automation in the libraries. Indeed there is almost no research done into the effects of open access CD-ROM workstation design on users of the service. This thesis has attempted to address this omission by concentrating on Charing Cross and Westminster Library. It would be interesting to broaden the research and discover how other institutions address human factors and the design of a CD-ROM workstation, if they do at all!

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APPENDIX 1

Specifications

Specifications

Item Description:

Item Number:

Display Screen   Yes No

1.   Does the screen have the correct
        number of available character
        spaces?   [ ] [ ]

2.   Is the display memory accessed by:

     * Roll scrolling   [ ] [ ]

     * Page number   [ ] [ ]

     * Pan screening   [ ] [ ]

3.   Is scrolling under keyboard control?   [ ] [ ]

4.   Is the screen clear from a distance of 2'   [ ] [ ]

Character size

5.   Is the character height greater than
     or equal to 3mm?   [ ] [ ]

6.   If there is the dot matrix character
     generation, do the dots merge sufficiently
     to produce a sharp and well defined image?   [ ] [ ]

7.   Is the resolution size of the dot matrix:

     * 5+7 (acceptable)   [ ] [ ]

     * 7+9 (preferred)   [ ] [ ]

8.   Is the character width 70-80% of the upper
     character height?   [ ] [ ]

9.   Is the stroke width between 12% and 17% of
     the character height?   [ ] [ ]

10. Is the space between the characters between
     20% and 50% of the character height?
     ie adequate?   [ ] [ ]

11. Is the row of spacing between 100% and 150%
     of the character height? ie adequate?   [ ] [ ]

12. Is it possible to display both upper and   [ ] [ ]
    lower case characters?

13. Do lower case characters go below the matrix
    line?   [ ] [ ]

14. Is it possible to distinguish between:

    * X and K   [ ] [ ]

    * O and Q   [ ] [ ]

    * T and U   [ ] [ ]

    * S and 5   [ ] [ ]

    * I and L   [ ] [ ]

    * U and V   [ ] [ ]

    * I and 1   [ ] [ ]

    Number 0 and letter O (If O is used tick___)   [ ] [ ]

15. If filters are used, are the characters
    sharply defined?   [ ] [ ]

16. Are characters upright and not slanted?   [ ] [ ]

17. Are the characters stable (ie do they
    flicker?)   [ ] [ ]

18. Are the colours of the characters:

    * White   [ ] [ ]

    * Yellow   [ ] [ ]

    * Green   [ ] [ ]

    * Other   [ ] [ ]

Cursor

19. Is the cursor provided?   [ ] [ ]

20. Is it possible to clearly distinguish the
    cursor from other symbols?   [ ] [ ]

Display screen and luminance   Yes No

21.   Can you adjust the luminance?   [ ] [ ]

22.   Is the control easy to reach?   [ ] [ ]

23.   At the maximum luminance do the characters
        stay sharply defined?   [ ] [ ]

24.   Is the background luminance between 15 and
        20 cd/m2 under the correct office lighting
        conditions?   [ ] [ ]

25.   Is the background luminance adjustable?
        (contrast)   [ ] [ ]

26.   Is the control easy to use?   [ ] [ ]

Adjustments

27.   Is it possible to adjust the orientation of
        the VDT on its vertical axis?   [ ] [ ]

28.   Can you adjust the screen angle ie
        horizontal axis?   [ ] [ ]

29.   Is the upper edge of the screen at or below
        eye height?   [ ] [ ]

Additional Characteristics

30.   Is the VDT resistant to knocks?   [ ] [ ]

31.   Is the VDT safe from electrical shocks?   [ ] [ ]

32.   Does the equipment satisfy national
        safety standards?   [ ] [ ]

33.   Is there access to the equipment for
        maintenance purposes?   [ ] [ ]

34.   Are the electricity cables:-

        * Adequately serviced?   [ ] [ ]

        * Flexible for future requirements?   [ ] [ ]

        * Unobtrusive?   [ ] [ ]

35. Are the operators and cleaning staff aware of which cleaning material may be used without causing damage to the equipment? [ ] [ ]

36. Will new security procedures be necessary? [ ] [ ]

Desks/Footrests

Item number:

37. Are there a sufficient number of work surfaces? [ ] [ ]

38. Is the surface of the desk matt finished? [ ] [ ]

39. Is the keyboard height: 70-80 cm? [ ] [ ]

40. Screen centre above the floor: 90-115 cm? [ ] [ ]

41. Screen inclination to horizontal: 88-105cm?[ ] [ ]

42. Keyboard (home row) to table edge 10-26cm? [ ] [ ]

43. Screen distance to table edge   50-75cm? [ ] [ ]

44. Is keyboard height adjustable? [ ] [ ]

45 Is the screen height adjustable? [ ] [ ]

46. Is the depth of the main table 90cm? [ ] [ ]

47. If not, how deep/high is it? [ ] [ ]

48. Is the width of the main table 120-160cm? [ ] [ ]

49. If not, how wide is it?   _____

Job Aids and other items of equipment

50. Are there copy holders? [ ] [ ]

51. Is there adequate space provided for the storage of

    *copies, handbooks, documents? [ ] [ ]
    *personal belongings? [ ] [ ]

52. Can the user easily rearrange the workplace
     for his/her personal requirements?   [ ] [ ]

53. Can all aids/equipment be used while
     maintaining the optimum working posture? ie

     * arm reach no more than 34-45 cm   [ ] [ ]

     * head inclined at ca 20   [ ] [ ]

     * spine slightly arched forward leaning
       from the side profile?   [ ] [ ]

     * upper arms vertical?   [ ] [ ]

     * no twisting of the head and trunk?   [ ] [ ]

     * thighs horizontal   [ ] [ ]

     * lower legs veritcal   [ ] [ ]

     * sufficient leg room both in height and
       depth   [ ] [ ]

     * frequent changes of the visual object
       accommodated within an angle of 15-30
       relative to the normal viewing direction [ ] [ ]

54. Are all the job aids and equipment positioned
     according to:

     * frequency of use?   [ ] [ ]

     * function?   [ ] [ ]

     * importance/sequence of use?   [ ] [ ]

Chairs

Item number:

55. Is the chair stable i.e. safe from
     tipping over?   [ ] [ ]

56. Is the chair provided with castors?   [ ] [ ]

57. Do the chairs satisfy national requirements?

Backrest 48-50cm between the seat
surface and top?   [ ] [ ]

32-36cm wide (averaging up to 95%
percentile)?   [ ] [ ]

Lumbar pad

     10-20cm above the seat? [ ] [ ]

     Concave?   [ ] [ ]

Seat 40-45 cm wide   [ ] [ ]

     38-42 cm front to back [ ] [ ]

     Dished   [ ] [ ]

     Waterfall edged?   [ ] [ ]

     Upholstered?   [ ] [ ]

58. Is the seat height adjustable?   [ ] [ ]

59. Is the height of the backrest adjustable?   [ ] [ ]

60. Can the backrest be adjusted forward and
backwards?   [ ] [ ]

61. Can adjustments be made from the seated
position?   [ ] [ ]

62. Is there guidance available on how to make
alterations to the seating position?   [ ] [ ]

63. Are all the seat adjustment leavers safe
from accidental release?   [ ] [ ]

Environmental conditions

Noise

64. Are there any high frequency tones in
   the microlab?   [ ] [ ]

65. Are there any external noises that affect
the microlab?   [ ] [ ]

Lighting

66. Is the users field of vision free from
direct reflection from the:

* display screen?   [ ] [ ]

* keyboard   [ ] [ ]

* desk?   [ ] [ ]

* paper   [ ] [ ]

67. Are the glare sources in the operator's
     field of vision - from lights, windows etc?   [ ] [ ]

68. If light is reflected in the screen is a
     light shield provided?   [ ] [ ]

69. Are the luminairies fitted with prissmatic
     or grid type fields?   [ ] [ ]

70. Does the lighting have 2/3 phase switching?   [ ] [ ]

71. Are the VDT's positioned so that the line
     of vision is:

* Parallel to the luminance?   [ ] [ ]

* Parallel to the windows?   [ ] [ ]

72. Is there an internal blind? What type?   [ ] [ ]

73. Are all the lights regularly cleaned?   [ ] [ ]

Room climate

74. Is the microlab air conditioned?   [ ] [ ]

75. Can the room temperature be maintained at
     between 21 and 23 C   [ ] [ ]

76. Can the humidity be maintained between
     45 amd 55%   [ ] [ ]

77. Is the speed of air movement less than
     O. 1m/s at:

* desk height?   [ ] [ ]

* waist height?   [ ] [ ]

* ankle height?   [ ] [ ]

157

APPENDIX 2

Interview Schedule

HUMAN FACTOR PROBLEMS ASSOCIATED WITH THE MICRO-LAB.

Charing Cross and Westminster Medical Library

Date of the interview   M/F

Time of the interview

First of all can I ask you...

1. Which user group do you belong to?

    Hospital staff   [ ]

    Nursing staff   [ ]

    Paramedical staff   [ ]

    Postgraduate staff   [ ]

    Undergraduate staff   [ ]

    Other: Specify   [ ]

2. How long have you been using the micro-lab?

    Less than 6 months   [ ]

    6 months to less than one year   [ ]

    1 year to less than 18 months   [ ]

    18 months to less than 2 years   [ ]

    More than 2 years   [ ]

3. On average how many hours do you use the micro-lab each month?

Daily   [ ]

Weekly   [ ]

Monthly   [ ]

4. Which terminal have you just used?

Terminal 1   [ ]

Terminal 2   [ ]

Terminal 3   [ ]

Terminal 4   [ ]

Terminal 5   [ ]

5. Have you used any of the other terminals in the micro-lab?

Yes   [ ]

No   [ ]

6. If you answered yes, which terminal do you prefer to use most often?

Terminal 1   [ ]

Terminal 2   [ ]

Terminal 3   [ ]

Terminal 4   [ ]

Terminal 5   [ ]

Please comment:

7. How would you rate your feelings and attitudes generally to automation and computers on libraries?

Very positive   [ ]

Fairly positive   [ ]

Indifferent   [ ]

Fairly positive   [ ]

Very negative   [ ]

8. Listed below are some reactions to the micro-lab. *Please tick all that apply.*

A. A good idea   [ ]

B. It improves prestige   [ ]

C. It is not needed   [ ]

D. An important facility   [ ]

E. It improves services   [ ]

F. Who cares   [ ]

G. Money could be better spent on other services [ ]

9. How do you think your colleagues react to the micro-lab and CD-ROM?

Very positive   [ ]

Fairly positive   [ ]

Indifferent   [ ]

Fairly negative   [ ]

Very negative   [ ]

10. In your opinion, should the facilities in the micro-lab be:

    Extended?   [ ]

    Kept the same?   [ ]

    Reduced?   [ ]

Automation

1. Do you have any problems with regards the following in the micro-lab?

		Yes	No
A.	Glare from the VDU	[ ]	[ ]
B.	Noise from the printer	[ ]	[ ]
C.	Heat from the VDU	[ ]	[ ]
D.	Glare from the desk surface	[ ]	[ ]
E.	Glare from the keyboard	[ ]	[ ]
F.	Noise from the VDU	[ ]	[ ]
G.	Computer failure/breakdown	[ ]	[ ]
H.	Other: Specify	[ ]	[ ]

Please comment:

2. Do you find the keyboards easy to use?

    Yes   [ ]

    No   [ ]

3. Do you have any problems with the following as regards
    terminal keys?

                                                             Yes No

    A. Angle of the keyboard to the desk surface [ ] [ ]

    B. Thickness of the keyboard   [ ] [ ]

    C. Reflection of the keyboard surface   [ ] [ ]

    D. Layout of the keys   [ ] [ ]

    E. Labelling of the keys   [ ] [ ]

    F. size of the keys   [ ] [ ]

    G. Feedback signal from the keys   [ ] [ ]

    H. Other: Specify   [ ] [ ]

    Please Comment:

Workplace Design.

1. Please can you rate the following aspects of the workplace in the micro-lab with regard to comfort and ease of operation.

		Good	Adequate	Poor
A.	Space on the desk	[ ]	[ ]	[ ]
B.	Length of the desk	[ ]	[ ]	[ ]
C.	Width of the desk	[ ]	[ ]	[ ]
D.	Area underneath the desk	[ ]	[ ]	[ ]
E.	Seat height	[ ]	[ ]	[ ]
F.	Seat height adjustability	[ ]	[ ]	[ ]
G.	Back rest	[ ]	[ ]	[ ]
H.	Back rest adjustability	[ ]	[ ]	[ ]
I.	Leg/knee clearence room	[ ]	[ ]	[ ]
J.	Access to/from the desk	[ ]	[ ]	[ ]
K.	Workstation as a whole	[ ]	[ ]	[ ]
L.	Other: Specify	[ ]	[ ]	[ ]

Please comment:

2. Do you think your job performance/satisfaction is affected by this?

Yes   [ ]

No   [ ]

164

3. How would you like this workspace to be improved?

Environmental Conditions.

1. How do you feel about the following general
conditions in the micro-lab?

A. Lighting

1. Too bright [ ]   2. Adequate [ ]   3. Too dark [ ]

Comment:

B. Temperature

1. Too hot   [ ] 2. Adequate   [ ]   3. Too cold   [ ]

Comment:

C. Humidity

1. Too dry   [ ] 2. Adequate   [ ]   3. Too moist [ ]

Comment:

D. Air circulation

1. Too still   [ ] 2. Adequate   [ ] 3. Too draughty [ ]

Comment:

E. Noise

1. Too noisy   [ ] 2. Adequate   [ ]   3. Too quiet [ ]

Comment:

F. Distance between terminals

1. Too crowded [ ] 2. Adequate   [ ] 3. Too isolated [ ]

Comment:

2. Do you think your job performance is affected by this?

Yes   [ ]

No   [ ]

Health and Safety

1. In the past six months have you experienced any of the following health problems at a terminal in the micro-lab?

	Yes	No
A. General tiredness	[ ]	[ ]
B. Headaches	[ ]	[ ]
C. Dizziness	[ ]	[ ]
D. Fainting	[ ]	[ ]
E. Cramps	[ ]	[ ]
F. Other: Specify	[ ]	[ ]

2. If you answered yes to 1 E, which areas of your body do you experience cramps while working at a terminal in the micro-lab?

	Yes	No
A. Neck	[ ]	[ ]
B. Shoulders	[ ]	[ ]
C. Arms	[ ]	[ ]
D. Hand or wrist	[ ]	[ ]
E. Upper back (above the waist)	[ ]	[ ]
F. Lower back (below the waist	[ ]	[ ]
G. Other: Specify	[ ]	[ ]

3. Do you attribute these to your work at the VDU screen?

Yes   [ ]

No   [ ]

4. How uncomfortable or comfortable do you find your work
   posture is for your:

                        Comfortable Adequate Uncomfortable

   A. Neck   [ ]   [ ]   [ ]

   B. Shoulder   [ ]   [ ]   [ ]

   C. Arms   [ ]   [ ]   [ ]

   D. Hands or wrists   [ ]   [ ]   [ ]

   E. Upper back   [ ]   [ ]   [ ]

   F. Lower back   [ ]   [ ]   [ ]

   G. Other: Specify   [ ]   [ ]   [ ]

5. Do you normally wear spectacles or contact lenses at
   work?

Yes   [ ]

No   [ ]

5b If you answered yes to this question, does this cause
   any problems when you work at the terminal?

Yes   [ ]

No   [ ]

167

Please Comment:

Stress

6. Would you describe your work in the micro-lab as being:

   Often stressful   [ ]

   Sometimes stressful   [ ]

   Never stressful   [ ]

   Please comment:

7. Do you have any other comments about the health and safety aspects of your work at the VDU terminal?

Personal Details

1. How do you rate the support you get from library staff in the micro-lab?

   Very poor   [ ]

   Poor   [ ]

   Adequate   [ ]

   Good   [ ]

   Excellent   [ ]

2. Overall, how happy are you with the physical features of the micro-lab?

   Very happy   [ ]

   Fairly happy   [ ]

   Indifferent   [ ]

   Fairly unhappy   [ ]

   Very unhappy   [ ]

   Please Comment: