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VISION AND THE VISUAL DISPLAY UNIT WORK STATION

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FOREWORD

This report was prepared by CIE Technical Committee 3.1, Visual Performance, as part of its working programme.

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– III –

SUMMARY

The introduction of Visual Display Units (VDUs) into everyday working life has often led to complaints of poor working conditions. This report is concerned with the visual aspects of VDU work as these have been the cause of some of the complaints.

The first part of the report examines the nature of VDU work. It is concluded that the visual tasks undertaken by VDU operators are essentially similar to conventional office work. However, the quality of the VDU display and the interaction of the display with the keyboard and any source documents, and with the visual environment in which the VDU is placed, can have important effects on the visual difficulty and hence performance of the task.

The second part of the report discusses the health aspects of VDU work. It is concluded that the most commonly occurring health aspects are some form of eyestrain and occasional aches and pains. The possibility that electromagnetic radiation emitted from VDUs may cause cataracts is dismissed.

The third part of the report considers the visual requirements of VDU work in three sections: the VDU itself, the visual environment in which it is placed and the visual capabilities required of a VDU operator. Detailed advice is given on suitable display and keyboard characteristics, on overcoming the problems of luminance imbalance and high luminance reflections in interiors and on such visual capabilities as the distances over which accommodation is necessary. The report is completed by a checklist which can be used to assess VDU installations.

RÉSUMÉ

VISION ET ECRANS DE VISUALISATION

L'introduction des Ecrans de Visualisation dans le travail quotidien a souvent entraîné des plaintes quant aux mauvaises conditions de travail. Ce rapport concerne les aspects visuels de ce travail sur Ecran de Visualisation qui ont fait l'objet de certaines des plaintes.

La première partie du rapport examine la nature du travail sur Ecran de Visualisation. On en conclut que les tâches visuelles accomplies par les opérateurs sur Ecran de Visualisation sont pour l'essentiel similaires à celles du travail conventionnel de bureau. Cependant les qualités du matériel Ecran de Visualisation, et les interactions de l'écran avec le clavier et tout document source et avec l'environnement visuel dans lequel l'Ecran de Visualisation est placé, peuvent avoir des effets importants sur la difficulté visuelle de la tâche.

Dans la seconde partie du rapport les aspects santé du travail sur Ecran de Visualisation sont discutés. On conclut que les aspects qui apparaissent le plus fréquemment sont des formes de fatigue oculaire et des douleurs occasionnelles. La possibilité que des radiations électromagnétiques émises par les Ecran de Visualisation puissent causer des cataractes est écartée.

La troisième partie du rapport présente les exigences visuelles du travail sur Ecran de Visualisation en trois sections: l'écran de visualisation lui-même, l'environnement visuel dans lequel il est placé et les capacités visuelles requises de l'opérateur. On donne un avis détaillé sur les écrans qui conviennent et sur les caractéristiques des claviers, sur la manière de résoudre le problème des différences de luminance et des réflexions de luminance élevée dans les intérieurs ainsi que sur les capacités visuelles par rapport aux distances auxquelles l'accommodation est nécessaire. Ce rapport se termine par une liste des contrôles utiles à l'évaluation des installations Ecran de Visualisation.

ZUSAMMENFASSUNG

SEHLEISTUNG UND BILDSCHIRMARBEITSPLÄTZE

Die Einführung von Bildschirmarbeitsplätzen in das Arbeitsleben hat oft zu Klagen über schlechte Arbeitsbedingungen geführt. Dieser Bericht beschäftigt sich mit den visuellen Problemen der Bildschirmarbeit, da diese die Ursache mancher Beschwerden waren.

Im ersten Teil wird die Arbeit mit dem Bildschirm charakterisiert, wobei die Sehaufgaben am Bildschirmarbeitsplatz und die Sehaufgaben bei herkömmlicher Büroarbeit als gleich eingestuft werden. Die Schwierigkeit der visuellen Aufgabe kann jedoch entscheidend beeinflusst werden durch die Qualität des Bildschirmgeräts, durch Wechselwirkungen der Anzeige mit der Tastatur und mit Arbeitsvorlagen sowie durch die Umgebung, in der sich der Bildschirm befindet.

Im zweiten Teil werden die die Gesundheit betreffenden Gesichtspunkte der Bildschirmarbeit diskutiert. Der Bericht kommt zu dem Schluss, dass nicht selten eine Art von Augenüberanstrengung und auch gelegentliche Augenschmerzen vorkommen. Die Möglichkeit, vom Bildschirmgerät emittierte elektromagnetische Strahlung könne zu grauem Star führen, wird jedoch zurückgewiesen.

Im dritten Teil werden die visuellen Anforderungen in drei Abschnitten betrachtet: Anforderungen an das Bildschirmgerät selbst, an seine Umgebung und an die Sehfähigkeit des Benutzers. Im einzelnen wird empfohlen, wie die Anzeige und die Tastatur günstig gestaltet werden können, wie unausgewogene Leuchtdichteverhältnisse und starke Reflexionen vermieden werden können und wie z. B. Akkommodationsentfernungen berücksichtigt werden müssen. Der Bericht wird schliesslich durch eine Check-Liste vervollständigt, die zur Bewertung von Bildschirmeinrichtungen benutzt werden kann.

TABLE OF CONTENTS

SCOPE	1
PART 1 THE USE OF THE VISUAL DISPLAY UNIT	2
1.1 Introduction	2
1.2 The visual display unit	2
1.3 The man-machine system	2
1.4 The visual task of the VDU operator	2
1.5 Conclusion	5
PART 2 HEALTH ASPECTS OF VISUAL DISPLAY UNITS	6
2.1 Introduction	6
2.2 Eyestrain	6
2.3 Aches and pains	7
2.4 Headaches, fatigue and irritability	7
2.5 Photosensitive epilepsy	7
2.6 Radiation	7
2.7 Conclusion	8
PART 3 VISUAL REQUIREMENTS	9
3.1 Display requirements	9
3.1.1 Introduction	9
3.1.2 Character formation	9
3.1.3 Character size	9
3.1.4 Intercharacter spacing	10
3.1.5 Upper and lower case letters	11
3.1.6 Line spacing	11
3.1.7 Format	11
3.1.8 Contrast and luminance	11
3.1.9 Blur	12
3.1.10 Character colour	12
3.1.11 Instability	14
3.2 Keyboard requirements	15
3.2.1 Introduction	15
3.2.2 Colour and reflection properties	15
3.2.3 Key legends	15
3.3 Environmental requirements	16
3.3.1 Introduction	16
3.3.2 Luminance imbalance	16
3.3.2.1 Static luminance imbalance	16
3.3.2.2 Dynamic luminance imbalance	18
3.3.3 High luminance reflections	18
3.3.4 Other environmental factors	20
3.4 User requirements	20
3.4.1 Introduction	20
3.4.2 Accommodation distances	22
3.4.3 Colour deficiencies	23
3.4.4 The onset of eyestrain	23
3.4.5 Visual rest centres	23
3.5 Conclusions and checklist	23
REFERENCES	26
Appendix 1 MEASUREMENT OF CHARACTER LUMINANCE	28
Appendix 2 NATIONAL STANDARDS AND OTHER AUTHORITATIVE DOCUMENTS CONTAINING SOME DISCUSSION OF THE VISUAL REQUIREMENTS FOR VDU WORK	29

SCOPE

This report examines the nature of work using visual display units (VDU) and offers guidance on the most suitable visual conditions for such work. The report is divided into three parts. Part 1 considers the ways in which VDUs are used. Part 2 examines the health aspects of VDUs. Part 3 discusses the visual requirements of VDU work and makes recommendations of appropriate visual conditions. The recommendations relate to:

- (a) the visual aspects of the VDU itself,
- (b) the visual environment within which the VDU is operated,
- (c) the visual capabilities necessary for a VDU operator.

This report does not deal with all the ergonomic aspects of VDUs and their operation, only those that interact with vision. Advice on other ergonomic aspects is available elsewhere (Cakir et al, 1980; Aust. Dept. of Science and Tech. 1981; Benz et al, 1981).

This report is intended for those who have to make decisions on VDUs and the environment in which they are operated. Specifically it is addressed to:

- (a) those who manufacture VDUs, so that their products will have desirable visual characteristics,
- (b) those who buy VDUs so that they can choose a VDU which has suitable visual characteristics,
- (c) those who install VDUs so that they can integrate them into a suitable environment,
- (d) those who use VDUs so that they can understand the nature of any problems they experience and devise suitable remedial measures,
- (e) those who assess VDU installations so that they have some basis for their judgements.

PART 1 -- THE USE OF THE VISUAL DISPLAY UNIT

1.1 INTRODUCTION

In recent years the VDU and its associated equipment have become a common feature of working life. Unfortunately the introduction of VDUs has often been accompanied by complaints of discomfort and fatigue from operators. Some of these complaints have been real in that they have been caused by deficiencies in the ergonomic conditions associated with the VDUs, whilst others have been spurious in that they have arisen from deeply felt concerns over such matters as the impact of VDUs on employment and the problems of modifying well established working practices. If this level of complaint is to be reduced in the future, it will be necessary to ensure that the VDUs themselves and the conditions in which they are used are better matched to the requirements of the operators. This report has been produced in an attempt to specify some of these requirements. It is concerned with the visual aspects of VDU work. This part, in particular, is concerned with the ways in which VDUs are used and hence the nature of the visual task associated with them.

1.2 THE VISUAL DISPLAY UNIT

Visual display units are manufactured in many different forms and at different levels of sophistication. Nonetheless, they all contain four basic components: a display which shows the information required, a keyboard which allows the operator to control the display, some control circuitry which provides a link between the keyboard and the display, and a connection to the central processor of a computer. This last element can be contained within the visual display unit itself or may be located remote from the VDU, but in all cases it accepts information from the keyboard and provides information to the display. Visual display units are manufactured for specific purposes, such as word processing, for general use such as in calculations, or as integral parts of scientific and industrial equipment. They may be built into special housings and fixed in position or they may be small and portable. Regardless of how they are constructed, the visual conditions to be described in this report are always relevant.

1.3 THE MAN-MACHINE SYSTEM

Visual display units do not operate in isolation. They are essentially an interface between the human and electronic world. As such, the ability of VDU operators to do the work required will be influenced by their own capabilities and by the characteristics of the VDU. Further, both VDU and operator may be influenced by the environment in which they are placed. In order to get most advantage from the use of VDUs, it is necessary to consider all three elements in this man-machine system: man, machine and environment.

1.4 THE VISUAL TASK OF THE VDU OPERATOR

Broadly, visual display units are used for three types of activity: information entry, data enquiry and dialogue. All three activities require the use of the display and the keyboard and may call for attention to be given to conventional documents as sources of data. The emphasis given to each component varies with the nature of the activity.

Information entry involves the input of either text or alpha-numeric data from documents into the VDU by means of the keyboard. Information entry is usually undertaken by skilled personnel using touch typing and working to a strict time schedule. The majority of the operators attention is directed to the source documents, with the keyboard and display only being used for checking (Grob, 1980), see Figure 1



Fig. 1 A VDU being used for information entry



Fig. 2 A VDU being used for data enquiry

Data enquiry is characterised by a flow of information from the computer to the operator. Typically, the operator requests information from the computer by use of the keyboard. The information required is then shown on the display and may be printed out. This activity is usually intermittent, attention being primarily directed to the display and the keyboard, see Figure 2.

Dialogue is characterised by the two-way flow of information between the operator and the computer, via the VDU. On some occasions information may be transferred from documents or directly from the operator to the computer; on others, information may be supplied by the computer to the operator. The pattern and frequency of use of display, keyboard and documents varies with the nature and flow of information, but in general the display screen and keyboard are viewed much more often during dialogue activity than for information entry (Grob, 1980), see Figure 3.



Fig. 3 A VDU being used for dialogue

This variation in the type of activity undertaken by VDU operators indicates that the visual characteristics of the display, the keyboard and any source documents are all important in determining the performance achieved and the comfort experienced by the operator. This raises an interesting question. Written and printed documents and keyboards in various forms have long been used in office work without causing widespread complaints, and the other element in the VDU, the display, essentially provides material similar to printed material. Now, if the three components involved in the activities undertaken by VDU operators are the same as, or similar to, well established equipment, for which widely accepted lighting recommendations exist, why is there such an outcry of complaint about the visual conditions prevailing in many installations of visual display units? (Cakir, 1978; Levitt, 1980; Smith et al, 1981). One reason is that the visual display unit differs from the conventional office equipment of printed and hand written documents and keyboards on typewriters in two important aspects.

The first is that the display, although it attempts to present information in a similar manner to that published as printed material, does not usually achieve its aim. In comparison with printed material, the "printing" of a display tends to have poorly formed blurred letters and numbers which may vary in brightness, contrast and position and may flicker. In addition, for some languages, accents which are an inherent part of the language may not be available. Further, the display of a VDU is a dynamic mode of presentation whilst the printed page is a

static presentation. All these aspects of the display can increase the visual difficulty of the task and cause discomfort to the operator.

The second aspect which distinguishes VDUs from conventional office equipment is the orientation and physical properties of the display screen. Most display screens are limited to a vertical or near-vertical plane and are specular to some extent. Conventional office equipment is usually movable over a wide range of planes, although it is most commonly found on a horizontal plane, and the surface is usually matt rather than specular. Conventional office lighting systems are not designed to deal with vertical, specular surfaces. Conventional office lighting installations tend to produce the wrong balance between the illuminance on the horizontal plane, which will usually contain any source document, and the vertical plane containing the display screen. Also, there is a tendency for the luminaires of the installation to cause specular highlights in the display. Both these aspects suggest reasons why the introduction of VDUs into a conventional office environment may lead to complaints of visual discomfort and fatigue. It is important to note that this observation does not suggest that existing knowledge of what causes visual problems is wrong. Rather it confirms existing knowledge. The point is that VDUs pose special visual problems and conventional office lighting installations are not designed to cope with these problems.

1.5 CONCLUSION

It can be concluded that the nature of VDU work is such that all three components used by the operator, source documents, keyboard and display, are important, although their relative importance varies with the nature of the activity undertaken. Each component has different visual requirements and the interaction between them may pose additional problems. The visual tasks done by the VDU operator are similar to conventional office work. However, the quality of the display and the interaction of the display with the other components and with the interior lighting may increase the visual difficulty of the task.

PART 2 – HEALTH ASPECTS OF VISUAL DISPLAY UNITS

2.1 INTRODUCTION

Surveys of VDU operators have revealed the widespread occurrence of various symptoms (Cakir, 1978; Levitt, 1980; Smith et al, 1981). The most common complaints are of eyestrain in various forms, muscular aches and pains, and more general reactions such as fatigue, irritability and headaches. These complaints are all temporary, in that with rest the symptoms disappear, but when they occur frequently they can reasonably be said to represent a condition of ill health.

The symptoms described above can all occur after a limited period of VDU work, hours rather than days. Most people will experience these symptoms if the visual conditions are poor. It is also possible that short term exposure to VDUs will affect particular aspects of health amongst people who have specific sensitivities. For example, work at a VDU could trigger paroxysmal activity in anyone who suffers from photosensitive epilepsy (Jeavons and Harding, 1975).

As for long term exposure, so far no deleterious effects have become apparent and experience with the analogous activity of television viewing does not suggest any such effects. Nonetheless, claims have been made that prolonged exposure to VDUs has caused lenticular cataracts to occur in a few people (Zaret, 1980). The validity of these claims is dubious (Vos, 1981).

Each of these health aspects of VDU work will be considered in order to establish the extent to which current knowledge suggests that VDUs and the visual environment in which they are seen are responsible for these symptoms.

2.2 EYESTRAIN

Eyestrain is a convenient term to describe a group of symptoms caused by visual work in poor conditions. The symptoms associated with eyestrain are:

- (a) irritation of the eyes, e.g. inflammation of the eyes and lids, hot itchy feelings about the eyes, etc.,
- (b) a breakdown of vision, e.g. blurring of vision and double vision,
- (c) referred effects, e.g. headaches, giddiness, indigestion, etc.

These symptoms are all temporary and will disappear with rest. The symptoms of eyestrain tend to appear whenever the visual system is called upon to act at the limits of its capabilities for any length of time. This means that eyestrain is likely to occur whenever the task is visually difficult, no matter whether the difficulty arises from poor lighting, from the inherent features of the task, from inadequacies in the individuals visual system, or from some combination of these elements.

VDU work can be visually difficult. Poor quality displays may produce small, blurred, indistinct images. The environment in which the VDU is operated may be such that high luminance areas appear on or adjacent to the display. The work place may be arranged in such a way that the operator has to focus at distances which are difficult for the visual system and has to adapt to rapid changes in luminance. If any or all of these conditions occur with the VDU installation then eyestrain can be expected to occur (Willis, 1981). However, if the recommendations on VDUs, environment and operator's requirements given in Part 3 of this report are carefully followed, then the probability of eyestrain occurring will be much reduced.