German standards for display work stations

H. KOCH

This paper reports the current state of standardization in the ergonomics of display work stations in the Federal Republic of Germany. The terminological standards have been published under DIN 66 233 Parts 1 and 2, and the technical standards under DIN 66 234 Parts 1–3 and Parts 5–7. Part 1 of DIN 66 234 specifies the minimum requirements for good character legibility. Part 2 describes the parameters for the perceptibility of characters, solely with reference to the display of light characters on a darker background. Part 3 gives recommendations on the grouping and formatting of data. Visual and audible coding is discussed in Part 5. Part 6 deals with display work station design, and Part 7 describes the working environment.

Keywords: display devices (computers); computer terminals; ergonomics; standards; Federal Republic of Germany.

The need to standardize the ergonomic aspects of display work stations was recognized in the Federal Republic of Germany more than ten years ago. At the suggestion of the Information Processing Systems Standardization Committee, the Federal Ministry of Labour and Social Affairs awarded a research contract to the Ergonomics Institute of the Technical University of Berlin[1].

On completion of this contract, the work of standardization began. Working Committee D was of the opinion that not only the displays but also the work stations and the working environment should be included in its deliberations. This research work and the ensuing standards have contributed to improved working conditions on visual displays.

TERMINOLOGICAL STANDARDS

At the beginning of any technological development, the engineers involved in the work at the different companies usually coin their own terms for the new products and processes. As a result, different nomenclatures evolve in the various centres of development within an area where the same language is spoken. This divergence in terminology hampers effective communication.

Standards for a field of technology should be internally consistent. Every technical term used should be as clear and as unambiguous as possible. For this reason, terminological standards were discussed side by side with the technical standards. The terminological standard has been published under DIN 66 233. The essential (although not all) terms relating to display work station technology have been defined in Part 1 of this standard.

Besides this special vocabulary, numerous already standardized terms, eg from physiological optics or lighting

The author is at Siemens AG, Zentrallaboratorium für Kommunikationstechnik, Postfach 70 00 72, München, FRG. He is Chairman of the Working Committee D Man-Machine of the German Information Processing Standardization Committee.

engineering, have also been used. To save users the trouble of referring to eight further standards, a compilation of terms from other standards that are used in the technical standards is provided in Part 2 of this standard.

TECHNICAL STANDARDS

The standardization work on adapting display work stations to man's physical and mental characteristics has proved to be an extremely extensive and complex undertaking. For the sake of early presentation to the public, therefore, the technical standards, which are published under DIN 66 234, were subdivided into various parts. Each of these parts deals with a single aspect of either the hardware or the software.

Part 1: Character shapes

This, the oldest part of the standard, gives recommendations on the shape of the characters — but no standard font is proposed. The Working Committee recognized that to standardize a font would impede technical progress.

On the other hand, the parameters that are important for the legibility[2] of any character font have been standardized. Probably the most important parameter is the font height h. As the edge of the picture element generated by cathode ray tubes lacks sharpness, the dimensions were referred to the centre of the (dot-shaped) element (Fig. 1).
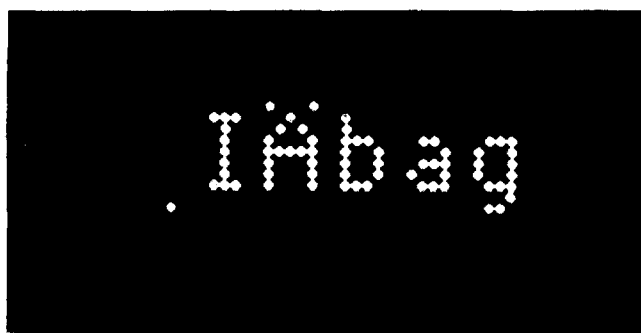

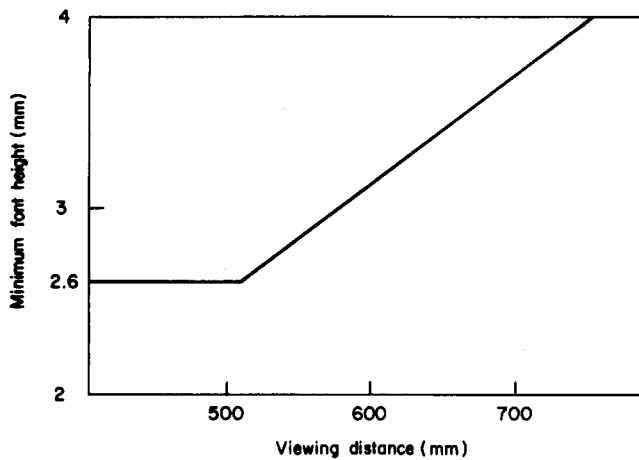Fig. 1 Character shapes formed by the dot scanning method

Fig. 2 Minimum font height h *as a function of viewing distance*

To ensure good legibility even for people with slightly impaired vision, the minimum font height h was defined as 18 minutes of arc or 2.6 mm (Fig. 2), and the character width, line spacing and character pitch were determined on the basis of this dimension.

Part 2: Perceptibility of characters on the screen

Technical progress in the use of cathode ray tubes for displaying characters is taking place very rapidly — technical development must of course precede ergonomic investigations and the standards based upon them. In this part of the standard, therefore, only the parameters relating to the perceptibility of light characters on a darker background could be standardized. The standard will be completed when sufficiently reliable information is available concerning the perceptibility of dark characters on a light background. A vital parameter is the luminance of the character and its background. The character contrast should be in the ratio of 6:1 to 10:1, and the character background should exhibit an adequate luminance.

Recommended colours for the characters are (in alphabetical order) green, orange, white/grey (achromatic) and yellow. Flicker is dependent upon numerous parameters, and no means of measuring it is available as yet. The standard is thus unable to propose a figure for this important parameter.

The standard does, however, quote figures for variations in character shape and character position, for fluctuations in character position, and for line and column distortion.

Part 3: Grouping and formatting of data

This part of the standard, together with Part 5, is thought to represent the first attempt to produce standardized specifications for the structure of user-friendly software. Thoughtful grouping and formatting of data is important, and not only for users working at the screen.

The standard offers suggestions on how the data should be grouped on the screen, how numeric data should be

organized and how coding schemes should be constructed. Guidelines and examples designed to prepare the ground for standardization are given in a new supplement. This contains definitions of screen areas, recommendations on user guidance (prompting) and advice on the format and content of screen information.

Part 5: Coding of information

Coding is, generally speaking, the assignment of one alphabet to another alphabet, in this case the assignment of more than one visual or audible signal to (associated) meanings. Part 5 gives thorough treatment to the visual and audible coding of information, including the information not displayed on the screen.

The coding of information is an important means of imposing order on the multiplicity of information and of directing the user's attention to important information. If man is to assimilate information reliably and quickly, it must be adapted to human 'communication channels' (eyes, ears, sense of touch); at the same time neither too much nor too little information must be presented.

This part of the standard summarizes the principal attributes and group attributes of visual and audible signals, and specifies the proper alphabets, elements and maximum number of elements that man can process in an alphabet (Table 1).

Table 1. Examples for optical signals, attributes, alphabets and elements

Main attribute	Group attribute	Proper alphabet	Recommended maximum number of elements	Examples of elements
Shape	Figure	Abstract graphical symbols	Up to 20 simultaneously; in special cases a higher number is possible	△□○+
	Pictograms	Up to 20 simultaneously; with familiar pictograms a higher number is possible	👤 🏠 △

Part 6: Work station design

The screen cannot be considered in isolation. The design of the work station and the layout of the working environment have a considerable influence on work at the screen. The basic principles of display work station design can be explained by reference to Fig. 3.

Some examples of display work station design are given in a supplement (Supplement 1).
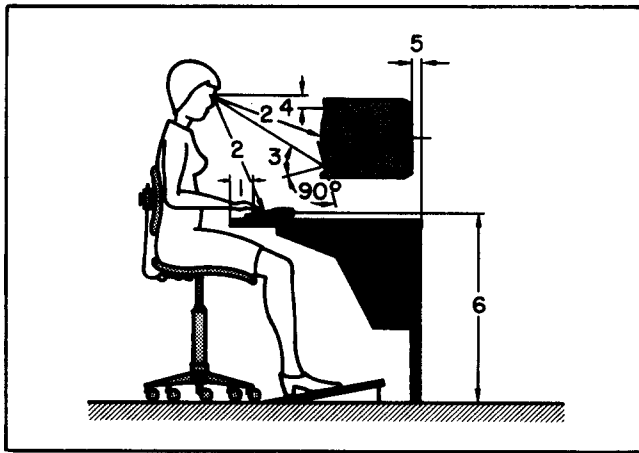
Fig. 3 Basic parameters of a display work station:

1 — the distance from the front edge of the desk to the first row of keys should be about 100 mm so that the hands can be placed on the desk during pauses in keying (= input);

2 — keyboard and screen should be independently movable about the desk so that each user can set the screen to the most comfortable viewing distance. The viewing distance should be adjustable between 450 and 600 mm. At this distance the keyboard can also be seen, so the eye does not have to make major accommodations;

3 — the viewing angle should not exceed 40°, so as to avoid unacceptable distortion of the characters;

4 — the top line should be below eye level because a downward inclination of the eyes is more comfortable;

5 — the display unit should not project beyond the rear edge of the desk so that people cannot knock into it as they go by;

6 — the distance between the floor and the home row of keys on the keyboard (row C in DIN 2139) should be about 750 mm on desks which are not adjustable for height, so that the user can assume a good sitting posture with the arms comfortably positioned;

7 — the source document should be placed so that unnecessary eye or head movements are avoided. As in the case of the keyboard and screen, the viewing distance should be between 450 and 650 mm;

8 — the surfaces of work aids such as desk, keyboard, screen frame and lectern should have a matt to silk-matt finish;

9 — very dark colours (reflectance less than 0.15) and very light colours (reflectance greater than 0.75) should be avoided.

Part 6 and its associated supplement are still in draft form at present.

Part 7: Ergonomics of the working environment, lighting and layout

This part of DIN 66 234 is still in draft form.

Working at a display work station entails a variety of visual tasks: reading and writing on the source document and reading the characters on the keyboard; reading the information on the screen.

A relatively high level of illumination is required to read illuminated characters, whereas luminescent characters can be read at a relatively low level of illumination. A nominal illumination of 500 lx has proved to be a good compromise. This value conforms to the specifications given in the standard on indoor lighting[3,4].

The front panel of display screens and other electrical indicators is made of glass, which reflects light. Every reflection represents unwanted information. The aim should be to illuminate the working environment and orient the display work stations in such a way that reflections from objects with a mean luminance (greater than 200 cd m^{-2}) are avoided. This can be achieved either by positioning the display work stations correctly in relation to the reflecting surfaces or by screening off reflecting surfaces (Fig. 4).

Display work stations should be positioned in relation to the main window area of the room. Ideally the operator's line of sight should run parallel to the windows. The display work stations should be set up between the rows of luminaires so that light falls laterally across the work surface. If the user sits with his back to the wall, as in work station A in Fig. 4, no lights can be reflected in the screen. If the room space behind the user is deep, as in the case of work station B, then the more distant ceiling lights can be reflected in the screen. In such a case lights with a limited radiation angle or baffles must be used.

Wherever possible no display work stations should be located in the immediate vicinity of the windows as the influence of variations in natural light is too great (cf work station C). However, if there is no option but to deploy display work stations in this area of the room, then the natural light should be shielded off with vertical louvres or curtains.

The special problems which arise in the planning of lighting for rooms in which display work stations are to be installed are dealt with by the standards committee on light in a separate standard.
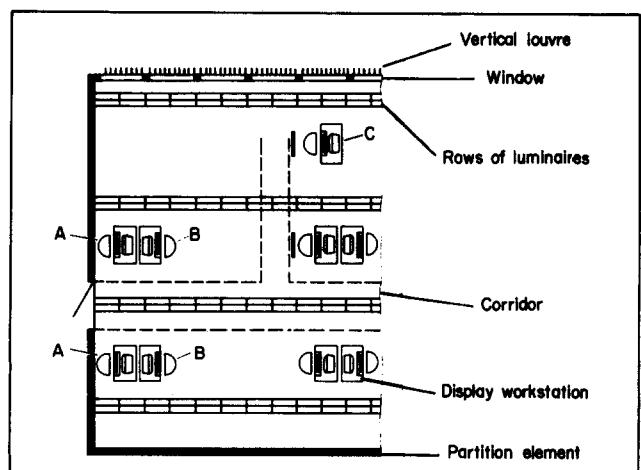

Fig. 4 Arrangement of display work stations in rooms with natural lighting and additional artificial lghting

OUTLOOK

A draft standard which describes the methods for measuring the values required in Part 2 is in preparation. Also in preparation is a draft standard relating to screen-based man-machine interaction. An extension of the present standard to include the representation of dark characters on a light background is planned.

The German standards have been submitted in the international standardization work of the ISO/TC 159/SC4 'Signals and Controls'. They have also influenced the work of the ECMA TC 28 'Recommendations for VDU Work Places'.

References

1 Cakir, A., Armbruster, A., Reuter, H.-J., V. Schmude, L. 'Anpassung von Bildschirmarbeitsplätzen an die physische und psychische Funktionsweise des Menschen Forschungsbericht' (Bundesminister für Arbeit und Sozialordnung, 1978)

2 DIN 1450 z.Zt. 'Entwurf, Schriften, Leserlichkeit'

3 DIN 5034 'Innenraumbeleuchtung mit Tageslicht'

4 DIN 5035 Teil 1 und Teil 2 'Innenraumbeleuchtung mit künstlichem Licht'