NOTES

Practical Application of Ergonomic Settings of Typical Computerised Workstations

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The goal of the study was to check, with regard to ergonomics, workstations equipped with visual display terminals in selected enterprises. Over 180 workstations were tested in 3 enterprises. Most workstations were equipped with computers. The ergonomics of both the parameters of the basic components of the workstation (i.e., a chair and a desk, and the position of the computer at the workstation and its screen with respect to windows) and lighting fittings were analysed. Typical mistakes in the layout of a workstation were chairs inappropriate for computer work, as well as broken chair adjustment mechanisms, which qualified chairs for repair or replacement. Wrong positioning of monitors on the desk and with regard to windows and lighting fittings was also noted.

computerised workstations   ergonomic settings   lighting

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1. THEORETICAL REQUIREMENTS

Workstations, whose basic equipment consisted of a desk, a chair, a central processing unit (CPU), a monitor, a keyboard, and a mouse, and—additionally—a printer were analysed. The evaluation of desks was conducted on the basis of a directive (Council Directive 90/270/EEC) and international standards (Standard No. ISO 9241-3:1992; International Organization for Standardization [ISO], 1992; Standard No. ISO 9241-4:1998; ISO, 1998a; Standard No. ISO 9241-5:1998; ISO, 1998b) taking into consideration Polish anthropometric data (Minister of Labour and Social Policy, 1998; Standard No. PN-91/N-08018; Polski Komitet Normalizacji, Miar i Jakości [PKNMiJ], 1991). A recommendation concerning computer workstations with regard to health and ergonomics was also taken into consideration in the study (Bugajska, 1997).

Light intensity measurements were conducted according to Polish Standards No. PN-83/E-04040.03:1983 (PKNMiJ, 1983) and No. PN-84/E-02033:1984 (PKNMiJ, 1984). Brightness was measured according to ISO Standard No. ISO 8995:1989 (ISO, 1989).

1.1. Requirements for Chairs

Working conditions at computer workstations depend to a large extent on the construction of the chair, which is related to musculoskeletal load. The chair should be chosen appropriately to the type of work. For work that is continuous and causes great musculoskeletal load (which was the predominant type of work at the assessed workstations), a professional type of chair is recommended. Such a chair has several possible adjustments, including armrests with adjustable height. For non-continuous work, a standard chair is acceptable. At least seat height and the height and angle of the backrest be adjustable in a chair like this.

1.2. Requirements for Desks

The desk should be chosen according to the type of work. If continuous work is performed at a workstation, which causes great musculoskeletal load (e.g., inputting data, data processing, computer-assisted design),

then greater requirements are placed on its ergonomic parameters. A desk with two individually adjusted tops is recommended for such applications. On the other hand, if work is non-continuous and does not cause a great musculoskeletal load, then the desk should fulfil at least the basic requirements: It should have two separate tops, with the keyboard top sliding under the monitor top, and the monitor top adjusted to the keyboard top.

1.3. Monitor Placement Requirements

A correctly placed monitor determines the work posture and the musculoskeletal load. In order to decrease the load on the motor system, the monitor should be situated on the desk in the following way:

- its screen should be at approximately 1.5 times the screen diagonal from the operator's eyes,
- its upper edge should be at the height of the operator's eyes or below,
- it should be situated with its side at least 1 m from the window.

1.4. Keyboard Requirements

A correctly placed keyboard conditions the load imposed on the upper limbs. In order to decrease the load on hands, the keyboard should be located at the height of the elbow joints. If this is too high, there should be special wrist-rests,

1.5. Lighting Requirements

A workstation that is properly designed with regard to lighting provides the employee with proper vision-based work conditions and at the same time it reduces the load on sight during work. It can also prevent sight ailments and diseases. A workstation that is equipped with a visual display terminal (VDT) should first of all have sufficient and even lighting, with special consideration for the desk, keyboard, and monitor. It is also essential that lighting fittings and daylight should not reflect off the screen. The conditions apply to both daylight and electrical lighting.

   Measurements of lighting at workstations, as opposed to the conducted ergonomic evaluation, must be carried out during specific weather conditions, and also at night.

2. STUDY MATERIAL

A total of 180 workstations equipped with VDTs were studied and evaluated. Most of the workstations (about 160) were equipped with personal computers. At most of the workstations, employees spent at least half of their work day. Work tasks were mostly editorial or involved data input. Video-encoding workstations equipped with two smaller monitors and a keyboard (about 20 keys) used for inputting five-digit sequences at the rate of about 30 per minute (0.5 Hz) were also considered as workstations equipped with VDTs. These workstations did not differ significantly from typical workstations equipped with personal computers.

3. RESEARCH METHODS

When evaluating workstations with regard to ergonomics, we decided to employ the participating observation method and interviews with employees in order to determine inconveniences noticed by employees when performing their daily activities. A checklist was used for workstation analysis. The workstation was checked for correct distances: the employee's eyes from the monitor, the height of the upper edge of the monitor in relation to the height of the eyes, the height of the desk top, the height and fitting of the chair to the natural curvature of the lumbar section of the spine. How big a part of the screen had daylight (windows) or artificial light (lighting fittings) reflections was also determined. For example, a change in the placement of the monitor in relation to a window or lighting fittings could increase or decrease reflections.

4. WORKSTATION ANALYSIS

Spatial management turned out to be the biggest problem at workstations equipped with VDTs. A correct arrangement of a desk, a chair, and a monitor with a keyboard allows easier and more pleasant work, and thus helps prevent musculoskeletal problems during work.

Tables 1 and 2 present the number of rooms and workstations where changes with regard to spatial management and improvement of natural and artificial lighting conditions were recommended.

TABLE 1. Recommended Changes in Workstation Conditions

Change	Workstations (total 180)	
	Number	%
Replacement or repair of chair	44	24
Replacement of desk	25	14
Change of monitor height	80	44
Change of placement of monitor with respect to window	54	30
Increase of space for operator	28	16
Change of distance between monitors or between monitor and another worker	15	8

TABLE 2. Recommended Changes in Lighting Conditions

Change	Rooms (total 97)	
	Number	%
Improvement of lighting in the room	19	20
Installation of curtains, shades, or blinds in windows	51	53

The height at which the monitor was situated was very often incorrect (Figure 1a) because it was put on the CPU. At workstations equipped with printers, switching the monitor and the printer changed the height at which the monitor was situated. The monitor is put on the CPU in the belief that this layout results in more space on the desk. However, space on the CPU can also be used as additional space for documents (in 16% of workstations). It is better to place the monitor directly on the desk, especially when it is big (17" or more). The upper edge of the monitor should be at the height of the operator's eyes or below. Such an arrangement ensures a correct position of the head and of the spine in its cervical part.

First of all, incorrect placement of the monitor with respect to sources of both natural and artificial light was noted (30% of all workstations). Monitors mostly had their back or front to the windows (Figure 1b). However, the best place—with respect to the window—for a monitor is with its side at least 1 m from the window. A good

arrangement lessens reflections of natural light off the screen, especially on sunny days. On the other hand, a monitor against the background of the window results in too big a contrast between the contents of the screen and the background, which results in quick fatigue of eyes.
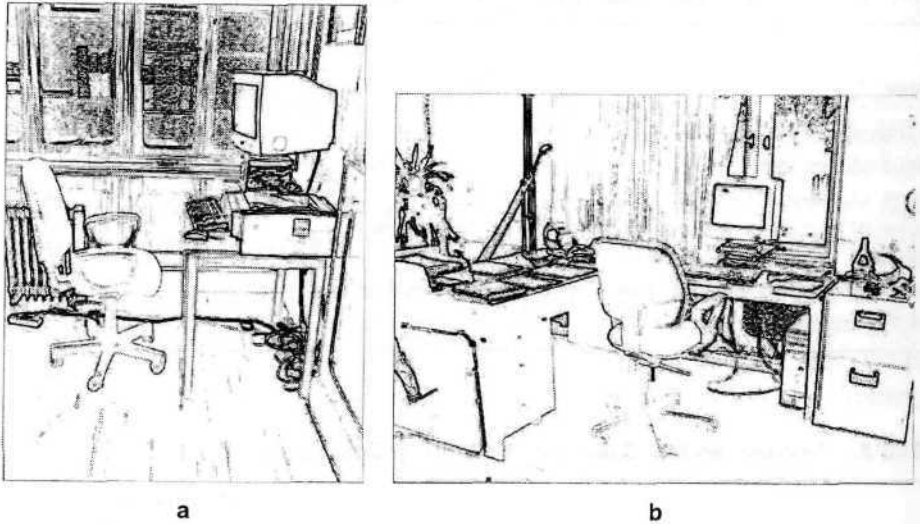

a   b

Figure 1. a—The monitor is too high on the desk, b—The monitor is incorrectly placed with respect to the window.

Curtains, shades, or blinds in the window (53% of rooms, Table 2) offer a way to decrease reflections off the screen. However, the goal is not to have any reflections at all.

Many chairs that were tested did not have working adjustments for easy adaptation to individual anthropometric features of the employee. It was suggested that the chairs with broken adjustments should be replaced with new ones or—if possible—repaired.

5. CONCLUSION

In total, 180 workstations equipped with VDTs (computers) were tested. In most cases, work space was incorrectly arranged. Most reservations concerned the following:

• the monitor at a wrong height—the monitor's upper edge should be at the height of the operator's eyes or below,

- bad situation of the monitor with respect to windows—its side should be at least 1 m from the window,
- bad chair at the workstation—the chair's adjustments of seat height and the height and angle of inclination of the backrest should be in working order.

An analysis of workstations equipped with VDTs proved that improving working conditions is very frequently related to improving the employee's knowledge about correct work space management and to bearing not-too-large costs of repairing or purchasing new office equipment.

The main cause of incorrect workstation management is the employees' lack of knowledge concerning ergonomics at work. That is why constant gaining and improvement of knowledge in the field of ergonomics and its practical applications is necessary.

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