

## **MAKING THE ERGONOMIC REQUIREMENTS FUNCTIONAL: THE CASE OF COMPUTERIZED OFFICE LAYOUT**

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The present paper deals with the ergonomic requirements related to the layout of computerized offices. These ergonomic requirements were worked-out with the aim to develop design suggestions on how to conceive ergonomic office layouts. Ergonomic requirements concerning work system components such as lighting, thermal comfort, physical workload, cooperation and work organization have been considered. Considering the form of the building, the lighting sources and the air-conditioning given, at a first phase, the ergonomic requirements were classified in two categories: (i) those related to the positioning of the office workstations, and (ii) those related to their orientation. At a second phase the different stages of the layout design process were considered. At a third phase we converted the ergonomic requirements to design suggestions for the different stages of the layout design process.

### **INTRODUCTION**

Ergonomics, responding to the ever augmenting number of white-collars working with computers, has produced a great amount of knowledge concerning the various components of work in computerized offices. This knowledge can be found in handbooks such as Grandjean (1987), Helander (1988), Sauter *et al* (1990), Wrennall (1992). Kroemer *et al.* (2001), in collective books and proceedings or in articles published in ergonomic journals.

Considerable improvement in working conditions, health, safety and productivity is achieved by applying this knowledge. That is why this knowledge has been transformed into regulating texts such as health and safety or design standards, legislation, etc. See for example Stewart (2000) and Çakir (2000) for reviews of ISO ergonomics standards for work on computers or Council Directive 90/270/EEC “on the minimum safety and health requirements for work with display screen equipment” which is mandatory for all member states of the European Union, as well as ANSI/HFES 100-1988 for Human Factors Engineering of Visual Display Terminal Workstations.

In a previous study (Marmaras & Papadopoulos 2003), we investigated the extent to which ergonomic requirements for work on computers are met in Greek offices.

The ergonomic requirements considered were those included in the Council Directive 90/270/EEC of the European Union and the ISO 9241 standard. Five hundred and ninety-three (593) office workstations were assessed using an assessment tool consisting of seventy (70) assessment points. The results showed that the ergonomic requirements that are independent of the specific characteristics of individual workspaces and environments (e.g., design standards for seats, monitors and input devices) are adequately met.

On the contrary, ergonomic requirements that should take into consideration the specific characteristics and constraints of individual work content, work spaces and environments (e.g., requirements dealing with workplace layout and environmental conditions, software and work organization) are inadequately met. We support that one reason for this is that the ergonomic requirements are usually formulated in a way convenient for assessing design solutions and existing work settings, but not facilitating their conception. Consequently, ergonomic requirements complicate the design process, as they constitute for designers additional constraints which have to be met.

The present paper deals with the ergonomic requirements related to the layout of computerized offices. These

ergonomic requirements were worked-out with the aim to become design suggestions facilitating the design process of ergonomic office layouts, for the case of already existing buildings.

### THE METHOD

At a first phase, we proceeded to a literature review with the aim at identifying the ergonomic requirements concerning work system components such as lighting, thermal comfort, physical workload, cooperation and work organization. Examples of requirements considered, are:

1. There should be no reflections of light sources on the screen.
2. The lighting should be uniform throughout the user's visual field.
3. There should be no annoying reflections or glare in the general work area.
4. There should be no annoying hot or cold draughts in the workplace.
5. The access to the workstation should be unobstructed and safe.
6. The layout of the workplaces should facilitate the cooperation.
7. The layout of the workplaces should facilitate the work flow (both of the personnel and the customers/visitors)

Considering the form of the building, the lighting sources and the air-conditioning given, at a second phase, the ergonomic requirements were classified in two categories: (i) those related to the positioning of the office workstations, and (ii) those related to their orientation. For example requirements 4, 5, 6, and 7 belong to the first category, while requirements 1, 2 and 3 belong to the second category.

At a third phase the different stages of the layout design process were considered. The stages that we considered are:

- Delimitation of the free space to be used.
- Design of workstation modules.
- Positioning of workstations.
- Orientation of workstations.

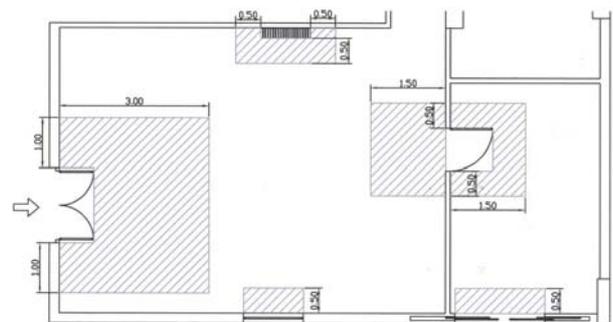
Having in mind the results of the three previous phases, at a fourth phase we converted the ergonomic requirements to design suggestions for the different stages of the layout design process. At the next section, we present the design suggestions we developed.

### SUGGESTIONS FOR ERGONOMIC OFFICE LAYOUT

#### Delimitation of the free space to be used

*Suggestion 1:* Before positioning the workplaces, delimit the following areas in which you should not put any furniture (free of furniture areas, *Figure 1*):

- 50 cm around any heating/cooling element,
- 50 cm in front of any window,
- 3 m in front and 1 m beside the main entrance door,
- 1.50 m in front and 0.50 m beside any other door.



*Figure 1:* Free of furniture areas

Following this suggestion we ensure the unobstructed maintenance of the heating/cooling elements and windows, as well as the free passage by the doors.

#### Design of workstation modules

*Suggestion 2:* For each workstation, design a module in the

following way (Figure 2):

- add along the front side of the desk an area of 55 cm width;
- add along the entry to the workstation side of the desk an area of 50 cm width;
- add along the back side of the desk (chair side) an area of 75 cm width.

Position these workstation modules instead of the desks and chairs.

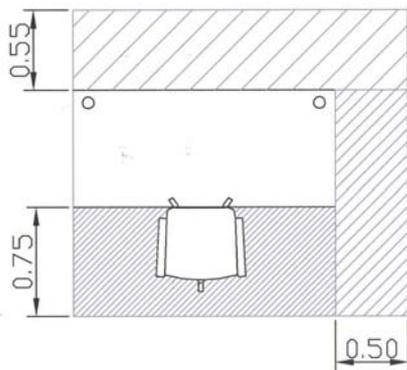


Figure 2: Workstation module

This suggestion ensures the creation of appropriate passages between the workstations, as well as enough space for unobstructed sitting and get up from the chair.

### Positioning of workstations

Workplace positioning should be mainly based on the cooperation of the employees, i.e., employees who cooperate tightly should be positioned near each other (Wrennall, 1992). Besides this, the following suggestions should be followed.

*Suggestion 3:* Start by placing the workplaces near to the windows, i.e., cover the areas near to the windows by priority.

Following this suggestion, the utilization of the natural light is optimized.

*Suggestion 4:* Do not place the employees near airstreams created by air-conditioners, windows and doors.

*Suggestion 5:* Avoid positioning the employees adjacent to windows with south, south-east and south-west direction.

The two previous suggestions ensure optimal thermal environment.

*Suggestion 6:* Position the workplaces in such a way that straight corridors leading the doors will be created.

*Suggestion 7:* Leave the required space in front and beside the electric switches and wall plugs.

The two previous suggestions ensure unobstructed passages and manipulation of electric switches and plugs.

### Orientation of workstations

*Suggestion 8:* Orientate the workplace in such a way that there are no windows in front or behind the employee when his looking towards the screen (VDT).

*Suggestion 9:* Orientate the workplace in such a way that there are no lighting sources behind the screen in the area shown in Figure 3.

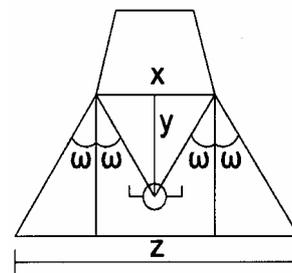


Figure 3: Area with no lighting sources [x : screen's width, y : employee's distance form the screen (40-60 cm), and  $\omega$  : reflection angle ( $\text{tang } \omega = x/2y$ )]

*Suggestion 10:* Orientate the workplace in such a way that there are no lighting sources in front of the employee within  $\pm 15^\circ$  in the vertical and horizontal direction from the line-of-sight (Figure 4).

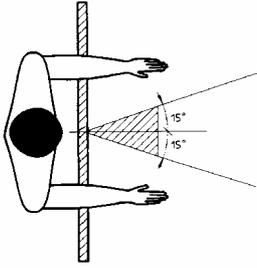


Figure 4: Orientation of the workplace in relation to the lighting sources

The previous three suggestions ensure that there will be no reflections on the VDT and the lighting will be uniform throughout the employee's visual field.

*Suggestion II:* Orientate the workplace in such a way that there are no entrance doors behind the employee.

### EPILOGUE

The present attempt to develop functional design suggestions differs from the classic guidelines developed by human factors engineering, as it joins the suggestions to the different stages of the design process.

Trying to follow the ergonomic suggestions, the designer may encounter contradictions. To resolve them s/he should be able to consider the more important and neglect the less important for the case at hand. Good knowledge of generic human abilities and limitations, as well of the specificities of the work which will be carried out in the designed offices, are prerequisites for successful decisions.

The suggestions presented in this paper will be incorporated in an integrated software tool for the ergonomic design of computerized offices which is actually designed by the authors.

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