FURNITURE SYSTEMS FOR THE AUTOMATED OFFICE

A THESIS

SUBMITTED TO THE DEPARTMENT OF
INTERIOR ARCHITECTURE AND ENVIRONMENTAL DESIGN
AND THE INSTITUTE OF FINE ARTS
OF BICKERT UNIVERSITY
IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF
MASTER OF FINE ARTS

By

Suitsa Farivarasadri (Avirai)
February, 1982
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February, 1992

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Furniture systems are widely used in offices which utilize computers and related equipments. However, these systems are not always efficient and do not satisfy the needs of the organizations and the users. The aim of this study is to analyze these systems used in the automated offices and to set some criteria for their design. These criteria are derived from organizational, functional and technical needs and ergonomic and social considerations.

Keywords: Automation, Office, Workstation, Workplace, Furniture systems.
ÖZET

ELEKTRONİK OFİSLER İÇİN MOBİLYA SİSTEMLERİ

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Anahtar sözcükler: Otomasyon, Çalışma Alanı, Ofis, İş İstasyonu, Mobilya Sistemleri
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# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABSTRACT</td>
<td>iii</td>
</tr>
<tr>
<td>ÖZET</td>
<td>iv</td>
</tr>
<tr>
<td>ACKNOWLEDGMENTS</td>
<td>v</td>
</tr>
<tr>
<td>TABLE OF CONTENTS</td>
<td>vi</td>
</tr>
<tr>
<td>LIST OF TABLES</td>
<td>ix</td>
</tr>
<tr>
<td>LIST OF FIGURES</td>
<td>x</td>
</tr>
</tbody>
</table>

## 1. INTRODUCTION

1.1. The Problem ................................4
1.2. Methodology of the Study ...................5
1.3. History of the Office ........................6
1.4. Prospectives in Automated Office Design...11
1.4.1. Integrated Furniture-Computers ..........12
1.4.2. Home Office ................................14
1.4.3. Participative Design ........................15
1.5. The structure of the Thesis ...............17

## 2. DEFINITION OF THE AUTOMATED OFFICE FURNITURE SYSTEMS

2.1. Different Types of Furniture Systems........22
2.1.1. System Type 1 ................................22
2.1.2. System Type 2 ................................24
2.1.3. System Type 3 ................................25
2.1.4. System Type 4 ................................26
2.2. Items of Furniture ............................27
2.2.1. Work Surfaces ................................28
2.2.2. Storage and Filing Components .............30
2.2.3. Lighting Components ........................33
2.2.4. Accessories ..................................33
2.2.5. Chairs .....................................35
2.3. Some Drawbacks of the Systems ...............36

## 3. ORGANIZATIONAL NEEDS

3.1. Work Flow .....................................39
3.2. Description of the Tasks ........................39
3.3. Communication ..................................41
3.3.1. Face to Face Communication ...............42
3.3.2. Paper Flow ..................................43
3.3.3. Communication by Telephone ...............44
3.3.4. Electronic mailing ..........................44
3.3.5. Tele-Conferencing ............................44
3.4. Filing system ..................................45
3.5. Equipments ...................................47
3.6. Facilities .....................................47
4. GENERAL CRITERIA FOR THE DESIGN OF THE OFFICE

FURNITUR

4.1. Basic requirements .................................. 50
4.2. Functional Requirements ................................. 51
4.3. Health and Safety Requirements .......................... 52
4.4. Maintenance .................................................. 54
4.5. Environmental requirements .............................. 55
4.6. Aesthetic Requirements ..................................... 56

5. ERGONOMIC CONSIDERATIONS .................................. 58

5.1. Postural Considerations ................................... 61
5.1.1. Recommended Postures .................................. 66
5.1.2. A Different Approach to Seating ......................... 69
5.1.3. Anthropometric Data ..................................... 71
5.1.4. Work Surface Height ..................................... 73
  5.1.4.1. Work Surface for Manual Tasks ..................... 73
  5.1.4.2. Keyboard Height .................................... 75
  5.1.4.3. Work Surface Height for Periphera Equipments ...... 77
  5.1.4.4. Storage and File Cabinet Height ................... 78
  5.1.4.5. High Counter's Height ............................. 79
5.1.5. Width and Depth of the Work surface and Horizontal Clearances .... 79
5.1.6. Chair ....................................................... 80
  5.1.6.1. Back-Rest ......................................... 82
  5.1.6.2. Seat Depth ......................................... 83
  5.1.6.3. Seat Width ......................................... 83
  5.1.6.4. Seat Height ......................................... 84
  5.1.6.5. Tilt of the Seat ................................... 84
  5.1.6.6. Arm-Rest ........................................... 84
5.1.7. Complementary Devices ................................. 85
  5.1.7.1. Foot-Rest ......................................... 85
  5.1.7.2. Palm-Rest ......................................... 86
  5.1.7.3. Document Holder ................................. 86
5.1.8. Different Recommendations for Different Jobs ........... 87
5.2. Visual Considerations ..................................... 88
  5.2.1. Glare .................................................. 89
  5.2.2. Different Levels of Illumination .................... 90
  5.2.3. Location of VDT in Relation to the User .............. 92
    5.2.3.1. Viewing Distance ................................ 92
    5.2.3.2. Viewing Angle ................................... 93

6. SOCIAL AND PSYCHOLOGICAL CONSIDERATIONS .................. 95

6.1. Organization's Structure .................................. 98
6.1.1. Conveying Messages .................. 98
6.1.2. Hierarchy and Status ................. 100
6.2. Interpersonal Relationships .......... 104
6.3. Individual Level ....................... 106
  6.3.1. Perception of the Space .......... 106
  6.3.2. Privacy and Territoriality ....... 107
  6.3.3. Self-Identity and Personalization 114
6.4. The Role of the Culture ............... 115

7. TECHNICAL CONSIDERATIONS ......... 117
  7.1. Wire Management ..................... 118
  7.2. Utilities for Personal Control of
       Environmental Factors ............... 124

8. CHECK LIST ................................ 127

9. CONCLUSION ............................. 137
# LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.1. Anthropometric data relevant to design of office workstations</td>
<td>72</td>
</tr>
</tbody>
</table>

ix
LIST OF FIGURES

Figure 1.1. Plan of Orenstein-Koppel, Dortmund, Quickborner Team, 1963.
Figure 2.1. Examples of automated and conventional workstations.
Figure 2.2. System type 1.
Figure 2.3. System type 2.
Figure 2.4. System type 3.
Figure 2.5. System type 4.
Figure 2.6. Typical automated work surface shapes.
Figure 5.1. Recommended postures for VDT users by Grandjean and Cakir.
Figure 5.2. A dynamic chair.
Figure 5.3. Forward slope and kneeling chairs.
Figure 5.4. Anthropometric dimensions.
Figure 5.5. Profile of a multipurpose chair.
Figure 5.6. The normal line of sight and the range of easy eye rotation.
Figure 7.1. Opening on the work surface.
Figure 7.2. Using hollow furniture.
Figure 7.3. Raceways within the panels.
Figure 7.4. Two alternatives for cable and wire management.
1. INTRODUCTION

Pulgram and Stonis (1984) define an office as:

The office, conventional or automated is an organization of people and equipment structured around specific activities and tasks. These tasks usually involve, in varying forms and levels of complexity, the generation, storage, and transfer of information (p.9).

In conventional offices, handling of information was done by traditional methods. The input data were written on the paper manually or using a typewriter and these papers were stored in paper file carts. The information transfer was done by paper, face-to-face or by telephone calls. Changing technology changed the way offices used to work. Using new electronic devices information necessary for task to be done is available to the operator on his/her desk. They can be processed, transferred, retrieved using these machines very quickly and without much physical effort. Tasks which took long time to be performed in conventional offices, such as retrieval of information, can be done now in a few seconds. Actually what is changing in an automated office is not the nature of the information, but the methods and equipments used in handling and processing it. Traditional means of information handling are replaced by electronic
information processing methods. Barcomb (1989) describes the concept of office automation as:

In a broad sense, office automation is the use of appropriate technology to help people manage information. Office automation is a concept, an approach to a new way of thinking about and handling information (p. 7).

Some areas of office work which the impact of the new technology is more strongly felt are:
- Text and data entry,
- Information retrieval,
- Information transfer
- Design and drawing processes,
- Tele-Conferencing,
- Project management, etc.

The evolution of this new technology also changed the design of the offices. In traditional office design, designer used to design the facilities and then housed people and their equipment in an attractive setting. The equipment used in traditional office were restricted to telephones, type-writers, desk calculators and the like. Designer was only concerned with the accommodation of the devices onto the available work surfaces. In an automated office, planning for new facilities must be integrated with the planning for the new machines as these machines are generally too big to be just placed on any work...
surface. In addition, they have special technical and environmental requirements such as electrical layout, air flow around the machines and special lighting. The ergonomic requirements for the comfort and health of the users of the VDTs (Video Display Terminals) are the other factors which should be considered while designing an automated workstation.

Furnishings of an automated office are critical to the proper use of the electronic equipments, to use of their full capacity and to the workers productivity, health and personal comfort. Furthermore, furnishings can contribute to efficient use of space and to its visual quality (Pulgram and Stonis, 1984). Another factor which makes the design of the automated office furniture extremely important is that, they should be sufficiently flexible to be able to adapt and accommodate the constantly changing new electronic innovations and different tasks of the workers created by changing business communication systems. Chorafas (1982) describes the importance of the automated office facility design as:

It is not enough to give to management, the secretaries, and clerical labor new, computer-based tools in order to improve productivity. The office as a whole must provide for maximum operating efficiency as well as flexibility. The interior must create a pleasing and attractive environment for employees and customers alike (p. 167).
1.1. The Problem

The increasing use of computers in different types of office in Turkey, such as banks, travel agencies, etc. has created a new need for suitable furniture, to be used with these machines.

As it was mentioned above, with continually evolving technology and the unpredictable nature of its development and products, one of the most important considerations around which all planning and design decisions should be patterned is that of flexibility. Flexibility involves ease of movement, adjustability, expandability, accessibility and adaptability. For this reason, modular furniture and furniture systems seem to be the best choice for automated offices. Since the concept of furniture system developed with the concept of open planning, the development of this type of office planning and the changes in the approach toward the furniture to be used in it will be briefly mentioned. Although the type of space selected for an office is highly influenced by the existing size and growth expectations of an organization, as the open planning seems to be the most efficient type of planning for the automated office (concerning the technical and environmental requirements and flexibility), furniture systems which are designed to be used in this kind of office will be studied. It should be remarked that
more private spaces can also be created in this kind of office using different sizes of panels. Moreover, many types of furniture systems can be used in both enclosed and open offices.

However, the problem with existing furniture systems is that these are either imported from the western countries or the anthropometric data used in designing them is taken from foreign sources. In addition, considering the fact that office furniture systems have been designed not only to allow individuals to carry out their working functions but to affect human behaviors as well, the differences in socio-cultural structures of Turkey and the other western countries (which brings about differences in social and psychological needs of the user), may result in some unwanted results while using these systems. Therefore, this study aims to collect universal criteria in design of office furniture systems, and to adapt them to the needs and characteristics of Turkish people.

1.2. Methodology of the Study

The study is based upon a literature survey. Universal approaches to the automated office furniture and criteria in design of these systems is discussed. Then using data taken from Turkish population, these criteria is adapted to Turkish society. Specially in chapter on ergonomic
considerations, Turkish population's body sizes is used to determine the dimensions and range of adjustability of the furniture items. When these dimensions are taken from the other books, the suitability of them for Turkish people is controlled. In discussion of social and psychological considerations also socio-cultural structure of Turkey is taken in to consideration.

1.3. History of the office

The first examples of the offices as we mean today, appeared about 1800's. These were small organizations with a single location, generally close to the factory they worked for. Face-to-face communication was the major form of communication in these early offices and a few existed written documents were stored in drawers of the tables. When the companies began to market their products in other cities,... a bulk of written documents began to occur between the company and the outside world. Invention of the type-writer in 1870's and later the usage of the telephone in the offices, made this communication with the outside world easier and faster and resulted in the appearance of larger and more complex organizations. As the number of documents in the offices increased, a need for regular storage of them appeared. Entrance of vertical file into the offices in 1893 and invention of the carbon papers in 1900's made the storage of incoming and outgoing
correspondences within an organization possible. From this time-on the companies could trust on an organization memory rather than the memories of the people working there (Galitz, 1984). All these new inventions resulted in the standardization of the office equipments and furniture items. Le Corbusier noted in his book "L'art Décoratif D'ajour D'hui" that "the type-writer led to the standardization of paper sizes, which in turn led to the standardization of file sizes, desk drawers, and ultimately of the entire furniture industry" (Le Corbusier, cited in Knobel, 1987, P.65).

Until the first years of the 20th century, working conditions in most of the offices were very bad. Natural lighting was used to illuminate the office space, thus in cloudy days and in the evenings workers had to work with a very poor lighting. It was in the 1920's and 30's that the importance of better lighting, ventilation and chairs in the offices was recognized. Usage of electric lighting, heating and ventilation systems beside acoustical ceiling in the offices began in late 1930's. Electric lighting and air conditioning made large interior office spaces usable throughout the year. By invention of the photocopying machine in the same years very quick duplication of the documents in the office became possible.

Wide use of the computers in offices in 1960's and 70's changed the way offices worked and made electronic
creation, storage and transformation of the information possible. It reduced the time spent in performing the office tasks. The first computers used standard type-writer-type keyboard as the means of interaction with the users and the output was taken by a hard copy printer. These computers were so big that could easily fill large rooms and were placed in data processing departments of the organizations. Advances in the CRT (Cathode Ray Tube) technology and pairing the computer with a VDT screen, made the interaction with these machines quicker and simpler. However, through the 1970’s computer terminals were their own furniture (an example is Sottsass and Bellini’s design for Olivetti company). Production of the first desk-top computer in late 1970’s by Apple company made it possible to transfer information to and from the computer from the desks.

Later improvements in techniques of displaying information, and detached keyboard from display beside rotatable and tiltable display screens which were factors derived from human engineering studies, made interaction with computers even easier. Later, advances in tele-communication techniques and facsimile production opened new horizons in office communication.

In addition to changes in information handling technology, office planning also witnessed serious changes during this
century. Until 1960's, most of the office buildings in the United states and Europe consisted of cellular private offices. Although there were some specific occasions which used big open offices, these open spaces were used as pool offices, furnished with rows of desks for the workers. The executives and managers were placed around this pool and occupied private offices. As the organizations became more complex and larger in size, the need for bigger offices emerged. The concept of open-plan office emerged in late 1950's and early 1960's, was a result of this need. The first example of open-plan was done by "Quickborner team for planning and organization" in Germany in 1958. The aim of the leaders of the group was to improve functional performance of offices. They became aware that existing office layout often has a harmful effect on work performance and rarely does what it should to perform. They believed that the presence of partitioning in office space was the key to the physical inadequacies of the office (Pile, 1978). So they designed offices without any permanent partitioning. As Pile (1978) describes:

Open planning is a way of layout office space without using partitions. The new open plan is based on a closely reasoned theory that suggests that partitioning is in almost all cases, not only unnecessary in offices, but detrimental to ideal office functioning (p.11).

The main critiques the Quickborner team made about the
conventional offices were that, the conventional planning is based on patterns defined by an organization chart and do not allow for logical and efficient work patterns. They claimed that built office environment blocks horizontal communication along functional lines. Moreover, they criticized the conventional layout for its inability to answer to the modern need for rapid organization changes, for its approach to storage problems (they believed that too much storage space encourages the growth of personal agglomerations of worthless materials) and for its cramped and depressing atmosphere (Pile, 1978).

The planning made by Quickborner team, named as office landscape, as Whiton (1974) mentions is based upon system analysis of work flow and communication which leads to floor plans and furniture layouts that are free and non-rectilinear. The first examples of this kind of planning in Turkey were designed between 1958 and 1960 (Erdemir, 1979). Figure 1.1 shows an example of early office landscapes.

Open-plan office allowed for a better way to expedite paper flow and allow easier and more productive communication between personnel (Pulgram and Stonis, 1984). Moreover it reduced the costs of carpeting, floor maintenance and energy consumption, as heat, ventilation and air conditioning are not impeded by the walls.
However, there are also some problems with the open-plan offices. Beside acoustical problems, privacy and status requirements created some rejections to this kind of office. Some of these problems related also to the furniture systems are dealt with in the following chapters.

Figure 1.1
(source: pile, 1978, p. 19)

1.4. Prospective in automated office design

Computer technology is improving with an enormous speed. Introduction of LCD (Liquid Crystal Display) screen, semiconductors, microchips and microprocessors are some of these advancements which led to the production of smaller,
less energy consumptive, cheaper, quieter, cooler and portable computers and peripheral equipments such as printers and facsimiles with a significant increase in their memory capacity. Miniaturization of the computers and developments in flat screen technology which replaces cathode ray tube monitor with liquid crystal display screens and frees up the work surface space, will show its effects on the design of the office furniture too. One result will be that the size and the form of the work surfaces can be determined more freely according to the needs and preferences of the users rather than the requirements of the equipments. Equipments may be easily put on any work surface or may be placed on smaller stands designed specially for this purpose. Furthermore, as a result of the improvements in flat wire, optical fiber, networking and wireless transmission technologies, fewer and smaller wires/cables will enter the workstation. This will consequently result in design of more flexible furniture with less need for wire management.

1.4.1. Integrated Furniture-Computers

A new trend in furniture design, which has become possible as a result of miniaturization of the computers is the integration of these "machines" with the furniture. An example is Apple's Workspace 2000 line (Young, 1990). These are a series of products designed by Patton design
group for Apple Company. Although they are not produced yet and have been made as prototypes, since the idea exhibits an interesting approach to the design of computer/furniture, is mentioned here. The idea behind the design of these productions has been that in recent years, most of the computer producers did not care about the interaction of the user with these machines and left this problem to be solved by furniture manufacturers. To solve this problem and to preserve the VDT users from sitting on the same spot in the same room for the best part of the day with minimal physical comfort and mental activity, designers working with Apple Company developed this new line as a new approach to the design of the workstation. As Young (1990) mentions about this series of products:

In this conceptual environment called workspace 2000, the user can stand, sit or move around freely using any one of a range of voice-activated and touch-sensitive computer pads, typically the size of an A4 notebook. There is also a pocket computer, the scroll, which has a roll-out screen (p.26).

The elements used in this "workspace" are performing both functions as furniture items and computers (and related equipments) together. For instant the work table can act as a screen also. The aim of this design is, like many other trends, to "humanize" the automated workspace and to give more control over the job to the user.
1.4.2. Home Office

Another consequence of the advances in networking, teleconferencing and facsimile is the appearance of home office concept. Today, a worker may work at home using a telecomputer, linked to a central office by phone, facsimile, electronic mail and networked computers. This technology enables many of the workers to spend at least part of their time at home. The aim is to make the quality of life and therefore work better and give the opportunity of working at home to many of the people who can not come regularly to the office such as working mothers, workers approaching retirement and disabled ones. Developments in home office, inevitably will bring about changes in office interiors. Since workers do not stay in the office for whole of the day, the personal workstations in this kind of offices will be eliminated and instead, people will share a pool of workstations and offices become meeting places and support centers.

There are also some rejections to the home office. The main point of discussion against working at home is that this type of industry requires moment-by-moment interaction with the co-workers for advice and motivations. Working at home may cause social isolation of the workers since people do not feel themselves as a part of a team. Besides, when offices change to pools of
workstations, no means of symbolizing the status, expression of personality, and conveying values of the organization to the workers exist which in turn cause people feel less commitment to the organization (Sundstrom, 1986-a). Despite of these discussions, home office is becoming a fact in our age because it creates work possibilities for many of the people who can not have a job otherwise. The role of the designers now is to decide about how these disadvantages of shared office can be reduced to minimum and how to design more flexible arrangements of furniture for home office which can bridge the gap between the leisure space and the work requirements.

1.4.3. Participative Design

The need to humanize the automated office and to make it a "pleasant alternative to home" forces designers to seek for new ways of office design to allow for more personalization of the workplace. This can be seen in an increased interest in self-expression through the selection and arrangement of the furniture and also in workers' preference for control over the environmental factors such as lighting, temperature and ventilation. This resulted in the appearance of participative design concept, which sometimes is called as "industrial democracy". Although this is not a new concept, and the
The first example of participative design was made in Central Beheer Company's office building in Apeldorn, Holland, designed by Herman Hertzberger in early 1970's (Duffy and Pye, 1979). This building was unfinished when it was occupied and the users were invited to finish it with their own decorations. Actually, this office is not an open-plan office but a collection of many private offices, so that any worker can have a personal "room". Yet, in an automated office with an open-plan, the characteristics of the furniture system also should allow for maximum involvement of the user in the design process. Participation in selection of the parts used in each workstation may help a lot since people do not like to feel that their personal workspace is imposed upon them without their involvement and consultation. Whatever a designer can do to involve people in the design of the new space adds to the value of the space and makes the environment more supportive for the users. Results of the Howthorne study (A series of experiments done by the Harvard Fatigue Laboratory at the Howthorne works of the Western Electric co. in 1927-32, which was responsible for the changed attitudes towards office environment) showed that "workers who could influence the appearance of their
surroundings could be expected to do better than those in offices of which the appearance and decoration were dictated by the management" (Forty, 1986, p.147).

Goodrich (1986) states that:

Not every office problem needs to be solved by a "design" solution. People can change, too. They are part of the problem, and they need to be part of any solution. Design approaches that emphasize user participation, openness and communication between user and designer are essential if worker acceptance is to be gained... Users will accept new design concepts if they understand how a particular solution was arrived at and how to utilize the new system effectively (p. 132).

1.5. The Structure of the Thesis

In the second chapter of the thesis the definition of the systems furniture and different approaches towards the design of these systems are explained. Under this heading, the different items of furniture used in an automated office, their functions, types and properties are discussed. In addition some problems which may be faced when using these systems are mentioned briefly.

Organizational needs are discussed in the third chapter. The effects of the organization's work flow, tasks performed, communication and filing systems, Equipments
used, and required facilities on the selection of furniture and its arrangement are discussed in this chapter.

In the chapter on General criteria for design of office furniture, general considerations in the design of furniture systems are mentioned. These include basic considerations in the design of furniture used in an open office, functional and safety requirements, those factors which make easy maintenance possible, environmental requirements and aesthetic considerations.

Ergonomic considerations are the subject of the fifth chapter. These are collected under two main headings, postural and visual considerations. In the former part the required posture while working with a VDT, the problems caused by improper furniture and the suitable dimensions for the items of furniture are studied. In the latter, the problems caused by the wrong placement of the VDTs according to the light sources, problems of glare and different levels of illumination and the correct placement of screen in relation to the user’s eyes are discussed.

Under the title of social and psychological considerations, the relation of the furniture and the structure of the organization, its role in the regulation of the interpersonal relationships and its effect on the individual worker are discussed.
Chapter on technical requirements investigates different ways of wire and cable management and the technical requirements of the utilities used in the automated office for personal control of the environmental conditions.

In the next part a check list is prepared to serve as a quick reference for the designers of the automated office furniture systems.

A point to be mentioned is that in the thesis beside the specific criteria for design of furniture for the automated office, general considerations for design of office furniture systems are also analyzed.
2. THE DEFINITION OF THE AUTOMATED OFFICE FURNITURE SYSTEMS

Scuri (1989) defines a furniture system as:

Furniture system indicates a group of furniture pieces and furnishing components which create well-equipped, well-defined and predetermined working areas (p.19).

These defined working areas are generally semi-enclosed areas named workstations that may accommodate one or more people. The size of the workstation is usually determined according to the functional needs of the occupant. The main difference between the conventional office layouts and furniture systems is that the conventional furniture items such as desks, filing cabinets, bookshelves and display boards are generally independent components whereas a system furniture is an integration of interdependent elements like work surfaces, filing components, shelving, and others, which rely upon panels or poles for support. These systems allow the creation of a great number of different combinations and have developed as a solution that would fit between the two extremes of the cellular office and the office landscape.

The first example of office system furniture was designed by Robert Propst and produced by Herman Miller company in
1964. It was a system of panels and interdependent components entirely suited to organize and integrate the worker and office task within an open-planning framework. It was a combination of panels and storage units, work surfaces, filing and display components that could be stocked on top of each other or hung from structural support panels which could be rearranged and relocated easily and quickly. Some main objectives of Robert Propst defined in his book (cited in Knobel, 1987) were: creating permissive surroundings capable of expressing the self-identity of the users and which motivate them, workstations with varying sizes to locate each substantial task in to a established workplace and to find a new language of enclosure and access which permits producing private places with adequate free access to each other. These objectives remained steady in most of the later produced systems as well.

The logic of the system is based on the module. The module determines the size of all system components with its fixed width. Pulgram and Stonis (1984) state that:

The more standard modules are 76 and 91 cm, although smaller increments are available at 38 cm (p. 118)

This modularity allows the efficient space utilization. Furthermore, space requirements for furniture systems are less than for conventional layouts because vertical space
is also used for storage, filing, display and other purposes.

An automated workstation, is distinguished from a conventional workstation by quantity and type of equipments utilized, particular requirements of the tasks, and the criteria that govern the design of its furnishings. An automated workstation should support changing functions and shapes, in equipment design and electronic related tasks which develop day by day. Figure 2.1 shows examples of automated and conventional workstations and their different requirements.

2.1. Different Types of Furniture Systems

Furniture systems are usually designed based on four methods of component assembly. These are discussed in the following sections:

2.1.1. System Type 1

The first type of furniture systems "utilizes free standing vertical screens with conventional type office furniture" (Reznikoff, 1979, p.66). This approach matches with the ideas of Quickborner team explained in the Introduction. The furniture items used are light and easy
Figure 2.1
Examples of automated and conventional workstations
(source: Pulgram and Stonis, 1984, p.125)
to be moved. Tables have minimal storage capacity, files are open carts and other kinds of storage are also discouraged. Panels are often slightly curved to obtain stability. These panels beside plants are the only means of breaking the open space. This kind of systems can be easily used in both open-plan and private offices (Figure 2.2)

![Figure 2.2](source: Reznikoff, 1979, p.166)

2.1.2. System Type 2

This type of systems use panels linked together to create self-stabilizing walls or dividers (Reznikoff, 1979). Work surfaces and storage components are suspended from these panels. The first examples of this kind were developed to take advantages of both conventional closed offices (particularly more privacy, territoriality, and quiet) and those of the open-plan office (such as improved communication, more efficient electrical layout and flexibility). The panels offer some degree of privacy
beside supporting the components. Using these systems, similar spaces to those existed in conventional planning can be created with more flexibility and less need to be locked to rectilinear, geometric layout. Any workstation can be outfitted in different ways to adapt any personal requirements. Since the storage components and work surfaces are supported by the panels, sometimes excessive use of them may be contradicted to the concept of openness. The advantages of this kind is that, it provides enough storage, any desired level of privacy and a high level of personalization of the workplace (Figure 2.3).

Figure 2.3
System type 2 (Source: Reznikoff, 1979, p.166)

2.1.3. System Type 3

Systems of this kind are built as storage-wall type massive cabinet units. These self-contained units are usually L-shaped and made of wood or steel that serve as
storage components, dividers (Reznikoff, 1979) and barrier for privacy. Often these systems also incorporate lighting components. Using these systems a higher level of privacy and more storage area can be provided but they are less flexible compared to previously mentioned types. However, these systems are generally more easily installed (Figure 2.4).

![Diagram of System Type 3](source: Reznikoff, 1979, p.166)

2.1.4. System Type 4

These systems are based on a table as the central element. Workstations are created by the combination of a table with storage components and flat panel elements (Pile, 1978). Storage, lighting and other necessary elements are raised above the table or attached to its sides. Panels are attached to the desks and using corner connectors, complex workstation units are generated. These systems
take as their premise that "space is at a premium in the modern office. So the designs eschew space-gobbling panels or separate storage units." (Knobel, 1987, p.102) Using these systems, designers attempt to obtain a relatively open space that provides a basic frame work for offices rather than carefully structured workstations (Figure 2.5).

![Figure 2.5](image)

**Figure 2.5**

System type 4 (Source: Steelcase, series 9000)

2.2. Items of Furniture

Any system of furniture is usually composed of the primary and secondary level work surfaces, either panel or floor supported, storage components which may be panel supported or mobile and which include filing units, shelve, overhead storage and the like, lighting components, accessories such as privacy panels and visual aids boards, and chairs.

Some of the items used are products for supporting equipments such as carousels and turn tables, pull-out
shelves or keyboard trays, document holders, etc. and some are task-support products namely storage units, file carts, media cabinets (to accommodate multiple storage needs) and others. Followings are some items of furniture used in an automated office:

2.2.1. Work Surfaces

-Desk or the standard office table is the basic unit of the office where most of the writing, reading, paper processing and telephoning occurs. Its size should permit the average person to reach papers and equipment on its surface from a central working position. In system furniture, more diversified methods of work surface support, more variety in work surface shapes and greater interchangeability of the parts are available. Usually rectangular and rectangular with round end tables are used for manual tasks. Panel-hung work surfaces and countercaps may be used in some systems as "desks and tables".

-VDT table; This table should accommodate VDT as well as document holder, portable task light, referencing and writing requirements. If the VDT is shared by a group, rotating turn tables or rotating carousels may also be used. Usually these tables are adjustable and available in different shapes. Besides rectangular and rectangle with round ends, $90^\circ$ corner and $120^\circ$ corner tables are also
used in the automated workstations. Of course there may be some other forms of the table suitable for use in an automated office, but the mentioned shapes are the ones which are most widely used. Figure 2.6 shows different tables used in an automated office. A VDT table should allow separate adjustments of VDT screen and keyboard heights. To serve this purpose, many of the VDT tables have a keyboard shelf which provides correct heights to permit comfortable keyboard operations. This keyboard shelf can be adjusted to a variety of vertical and horizontal positions and angles. In some of the systems surfaces for electronic equipment include built-in wire management.

![Diagram of table shapes](image)

**Figure 2.6**

Typical automated work surface shapes

(Source: Pulgram and Stonis, 1984, p.134)

-Printer table; Printer may be placed on a work surface or may be free-standing. In both cases required depth, width and height dimensions and service/maintenance allowance should be provided. Printer may be sheet-fed or continuous-fed. The former type should be located within
or near reach of the operator and the latter needs sufficient space behind units for paper handling. Moreover, a paper hanger can help keeping printout paper easily accessible and neatly in place. If the printer is used by a group of people, mobile printer support table with casters may be used to obtain convenient shared access. For noisy printers, printer closets or sound hoods can be used to control printer-generated noise at the automated workstation.

- Conference table; It is used for meetings of four, six or more people. A rectangular table with a curved end may be used both as a VDT table and as a table for primary conferencing and a circle or ellipse table for more formal conferences.

2.2.2. Storage and Filing Components

- File cart; It is used to store active files and general work papers at the workplace. The unit should be designed for suspended file folders and should accommodate letter, legal size paper and computer print-outs.

- Group File; This unit is used to store the active and semi-active files and work papers which are used by a group. It is similar to but larger than file cart. Some group files may be designed with two levels for working
both in a standing and seated position. At each level of the unit, work surface for sorting, searching and filing papers should be provided.

Filing components in automated workstation; Beside the file cabinets and file carts which are used to store paper documents both in the automated and conventional offices, there is a need for storage of other media such as magnetic and optical disks, microfilms and others in an automated office.

- Computer-based storage media such as magnetic tape reels, cassettes, cartridges, floppy discs are typically filed in separate trays that can be slipped inside lateral or pedestal file drawers, placed on shelving units or stored within special media drawers and cabinets, shelving dividers, paper organizers or special EDP (Electronic Data Processing) storage boxes integrated within the system (Pulgram and Stonis, 1984).

- Micrographic-based filing; It involves storage of information on magnetic film media that has been photographically reduced in size and format. For these media depending on the particular microform used, a wide variety of filing forms are possible. The primary storage unit for the roll-film is a standard pedestal or lateral file fitted with trays or drawers. They can be also stored
in special media cabinets fitted with hanging racks, in
desk-top carousels or in lazy-susan style rack units. Microfiches and ultrafiches may be stored in file sleeves and folders with enclosure pockets for microfiche sheets. These can fit to the standard and lateral file drawers or shelves (Pulgram and Stonis, 1984).

-Book case; It is used for storage of active bound materials such as books, magazines and reports. The shelves of the book case should be interchangeable to accommodate different materials.

-Wardrobe; This is a storage unit for personal items. It is used often to prevent workers from storing their personal belongings in the workstation. Sometimes the sides and the backs of the wardrobes may act as visual/acoustical screens and provide sound absorption for areas adjacent to the units.

-Drawer units; These may be hung under the desks and the work surfaces. In addition mobile drawer units may be designed. These drawers should have different sizes and shapes to accommodate pens, pencils, papers, and other items.

-Shelf-storage units; These may be produced in different widths, depths and heights and may be open or closed.
2.2.3. Lighting Components

Workstation may also include lighting components. Some of the systems include only task lighting, which may be integrated within the workstation or designed as a separate item which can be attached to the work surfaces, whereas some others may also include ambient lighting. This ambient lighting may be free-standing or integrated within the workstation.

2.2.4. Accessories

-Visual aids board; These boards may serve as black or white board, tack board and/or bulletin board and are generally used in conference areas or those workstations which require conference facilities.

- Visual/acoustical screens; These screens are used to provide privacy for individual or group workplaces. Generally, these screens are available in at least two heights. Higher screens provide visual privacy for a standing person, whereas the lower ones cut the line of sight of a seated one. Usually other heights of the panels are also available in a system furniture. Even full-height panels which can create spaces similar to the traditional private office are used in some of the systems. Erentok (1991) states that in open offices standardized panels
with different heights such as 140, 160, 180, 200, 220 cm are used. Some of these panels are used as acoustical screens. When used for this purpose, the surface of the screen is usually covered with fabric, porous enough to permit sound transmission. Under this surface, a sandwich construction consisting of a sound-absorbing material, a sound deadening core, and another sound absorbing material and fabric surface exist. These screens may also serve as tack surfaces and/or support for some accessories such as coat hangers, lighting devices,... Pulgram and Stonis (1984) state that "these screens are generally available in a wide range of heights and widths, from 76 to 203 cm high and from 51 to 152 cm wide" (p.52). Screens may be structural support panels, or non-structural, interlocking or free-standing panels. Different finish options for these panels are: hard-surface treatment for non-acoustical panels, soft-surface for tackable and acoustical ones and transparent panels used as "windows". Sometimes these panels are used as means of wire management providing special raceways, and outlets. Wires and cables can be threaded through these raceways and electronic equipments can take electricity from the provided outlets. This is discussed in the chapter on Technical Considerations in detail.
2.2.5. Chairs

There are different kinds of chairs used in an automated office. These can be classified in three main groups as follows:

The first kind is the typical desk chair used for writing, paper processing, telephoning, etc. This kind of chairs should roll easily on the carpet, swivel and should have adjustable seat height and tilt tension.

The second type of the chairs are designed specially for VDT users and usually more adjustment features and greater emphasis on ergonomic criteria is necessary. This kind of chair is discussed in detail in the following chapters.

The third kind of chairs include conference, reception and desk side chairs. These often do not need to be adjustable but conference seats characteristics are related to who use them and sometimes can approach the comfort and adjustability of executive seating.

Other kinds of chairs may be found in the market such as executive, management, operational and secretarial chairs. In fact, all these seats can be placed in one of the mentioned groups, the only factors separating them are the level of adjustability, the height of the back-rest and
the quality of materials used. These features become important in some of the chairs as status markers like high back-rest and luxury upholstery for executive chairs,... In an automated office when deciding about the seat used in a workstation, the task that worker performs, the time spent using VDT and the importance of ergonomic design for each task are the most important features to be considered.

3. Some Drawbacks of the Systems

The basic problem with most furniture systems is that they restrict the furnishing choice of the user because they already contain all the elements. Moreover, usually systems produced by one manufacturer are not interchangeable with any other system (Reznikoff, 1979). Even if technically it is possible to combine two or more systems, in order to maintain a constant look in the office, generally the designer have to use the components produced by a single manufacturer. When a kind of system is decided for an office, some parts may be added to it but components from another system can not be mixed to that system. So a client is locked to the system for many years and unless complete reinstallation, new systems can not be used in the office. In this case careful evaluation of open plan systems is necessary before any decision about the type of the system used is made.
Another reason for resistance against systems is that many people feel that "modern life in all its aspects is becoming too much a matter of systems, acting in a way that sometimes seem out of human control" (Pile, 1980, p.156). Although furniture system is the characteristic of our time, the idea that all furniture in an office should be a part of any one unified system is not attractive in human terms. The solution may be designing more flexible systems with possibility of combination of the parts with free-standing items and a wide variety of colors, finishes and shapes for the system's components.
A very important factor in determining the type and number of furniture items required in an office as well as their arrangement is the organizational needs that should be served. Wagoner and Ruprecht (1987) state that:

A coordinated office work flow requires both face-to-face communications and electronic communications. The flow of paper documents and materials from management to workstation must be smooth. There must be control of internal and external paper traffic, and the physical grouping of the employees must match their activities and tasks (p. 322).

Thus, the grouping and positioning of the workstations should be in accordance with the team and departmental activities and tasks. Moreover, external visitor traffic have to be channeled to bypass work areas without interfering with individual and group tasks, and the placement of common files, equipment and services have to serve participating groups of individuals. So in order to make a functional planning, which serves the purposes of the organization in the best way, following matters should be studied carefully:
3.1. Work Flow

An analysis of the work method of the organization, the number of the people who work there and the description of their jobs should be done. This includes information about the total number of employees in the office, the number of personnel in each department, the job of each of them, the way an input data enters to the office, the way it is processed within a department and the way it passes from one department to the other.

3.2. Description of the Tasks

At the second step the tasks performed, the way these are classified in the organization's hierarchy and the requirements of individual workstations should be determined.

There are three basic ways of performing tasks in an automated office. These are as follows:

The first group of tasks are those which must be performed on electronic equipment. Data entry, data retrieval and word processing are some examples of this kind. While operating these tasks, beside VDT and keyboard, peripheral equipments such as printers and plotters may be used.
The second category of tasks consists of those which involve part-time use of the electronic equipment. These include writing, documenting and conferencing activities. Electronic equipments have just a partial role in operating these tasks. Some of the personnel who need part-time access to electronic equipment include: administrators, technicians, and programmers.

The third group of tasks are those that do not involve any electronic equipment. Report and document writing, reading and sorting papers are some examples. Generally secretaries and clerks perform this kind of tasks in an automated office.

To decide about the requirements and configuration of the workstations, the number of people who are going to work at any workstation, the kind of the task they perform, the equipments needed and the relationships of the workers to the equipments should be identified carefully. Then according to the results gained, considering the time spent to perform a task and the frequency of using the machines and other equipments, decision about the configuration of the workstation, the component requirements and the placement of the primary and the secondary worksurfaces as well as storage items will be made.
3.3. Communication

Communication within the organization relevant to the work flow is a major factor in decision about the arrangement of the furniture. Elements of communication which should be studied are: Sender (the person who has something to communicate) and a recipient (the person who receives the message). The sender transmits a message, using a particular medium, such as face-to-face conversation, or telephone, to the recipient. Generally there are two lines of communication flow in any organization. Vertical communication is the communication flow towards the recipients of a higher or a lower rank. Horizontal flow may be defined as the flow of communication towards recipients of the same rank. To these two major communication lines within the organization, a third line, communication with the public might be added also. Traditionally, within the office environment dominant media of communications were paper processing and flow, direct communication (that is face-to-face) and telephone usage. Electronic technology is significantly affecting these conventional forms of communication. VDT interaction now becomes the main form of interaction in automated offices. Pulgram and Stonis (1984) describe these changes as follows:

Paper generation, storage, and flow are gradually diminishing, the central file is being supplemented with magnetic media.
storage, and direct communication is being replaced by the digital and video transfer of messages, voice and image (p. 29).

This transition to electronic-related systems and products may dramatically affect traditional adjacency relationships, type of the furniture chosen and layout planning.

3.3.1. Face-to-Face Communication

Although the importance of the face-to-face communication is decreased in automated offices, it is still used and preferred in many of the cases. Galitz (1980) reports the results of a review of six recent studies and concludes that:

The purposes of using face-to-face meetings for communication include person-oriented discussion, dealing with strangers, short travel time/journey, prolonged discussion, negotiation and persuasion (Galitz, quoted in Sundstrom, 1986-a, p.255).

Sundstrom (1986-a) also mentions that electronic communication is likely to replace only those meetings with lowest priority. So the importance of person-to-person meetings should be noticed in planning the office.
3.3.2. Paper Flow

The analysis of paper flow within the organization also gives vital information to the designer about the communication flow within the office. Although in "electronic office" it is possible to transfer the information via equipment such as word processor, there is still a need for the actual physical transfer of documents in many activities. Actually in spite of all predictions that offices will be paperless in the future, the use of paper continue to grow (Kleeman, 1990-a). Thus to determine the needs of the organization, paper flow analysis provides important clues. This analysis is done to determine where the selected paper flow network originates in, or enters into the department, or the process is terminated. It also gives information about the intensity of communication by paper in the organization.

3.3.3. Communication by Telephone

Moreover, the role of telephone in communication system have to be studied as now it is possible to handle many of the informations in the form of electronic data by the telephone and it becomes an essential tool in the flow of information.
3.3.4. Electronic Mailing

Another way of transformation of information in the automated office which should be considered, is electronic mailing. Information can be input in electronic form through a keyboard and routed to the recipient. At the receiving end, the information is displayed on a VDT screen or is printed out on hard copy.

3.3.5. Teleconferencing

A recent development in communication means is the appearance of teleconferencing. There are three primary forms of teleconferencing: voice, computer, and video. In voice teleconferencing, high-quality "speaker phones" are used and participants communicate over telephone lines. So, the participants may contribute to the conference from their individual workstations. In computer teleconferencing computer terminals are used as the mean of communication where dialog is stored in computer memory to be read either immediately or at a future date. Video teleconferencing is possible using television cameras, microphones, video display monitors, and electronic blackboard equipment. Utilizing this technique, proceedings can be stored on video tapes or video disks for future references.
Thus, a communication flow study may give information to the designer about how frequently these media are used and the communication means required for any single workstation.

3.4. Filing System

Filing system is another subject which should be studied to determine the needs of an organization. It gives information about file material categories, quantities of the materials in these categories, intensity and scope of usage, and techniques used in filing them. Filing system analysis may begin with a sample survey to understand the present situation. Then according to the results gained, decision about the accepted classification system and standardization of the files is made.

Usually, there are three types of files available in an organization. These are:

- Active files: These files are used frequently and are generally placed in individual workplaces.

- Semi-active files: These are generally used within a group and are placed in a way that is accessible for all the members of the group.

- Inactive files: Are those files which are used
infrequently but necessary to be stored.

There are three systems of information storage and retrieval used in automated office. These are:

- Paper-Based Filing; This involves manual filing of paper outputs which include the conventional paper output as well as the hard copy output of electronic printers, copiers, and facsimile equipments.

- Computer-Based or "Electronic Filing"; It involves the direct storage of the information in computer's memory or the transformation of them on to the magnetic or optical storage media.

- Micrographics-Based Filing: This involves the storage of the information on magnetic film media such as roll films or micro fiches.

Although the storage of the information on disks or micro fiches may need much less storage area and expense, still there is a need for paper files in many cases as many documents have, by low, to be retained. They can not be replaced by microfilm or by electronic storage media. However, today it is possible to store and retrieve to these materials using new technologies. Vincent and Peacock (1985) state that:
Machines which automatically file and retrieve these documents have been developed, using micro-processor-type electronics to control and record all document movement and locations (p. 98).

Important considerations in filing system analysis are filing techniques, filing criteria and filing places.

3.5. Equipments

The equipments necessary for any specific task and their requirements for floor space, support, special items of furniture and so on should be studied carefully.

3.6. Facilities

Facilities which are needed within the office, the number of people that they accommodate and their special structural and functional requirements have to be determined.

In the mentioned analyses specific data-gathering techniques are used. These include observations, interviewing with users and managers and using questionnaires. According to the results of these studies, graphic charts and diagrams are made and adjacency requirements are determined. The adjacency requirements
are born out of the relationships which exist within a functional unit and between functional units. Pulgram and Stonis (1984) classify these relationships as:

Relationships within functional unit:
- User(s) to user(s),
- Users(s) to group items and spaces, that is, equipment, storage, conference spaces, and so on.

Relationships between functional units:
- Group to group
- Group to ancillary, that is, conference, central computer or word processing facilities
- Specific user(s) to user(s)
- Specific user(s) to group(s)

(p. 29).

Space calculation and development of workplace standards are other concepts which are developed based on the informations drawn from the above-mentioned analyses. These standards are determined according to the existing and future organizational requirements based on the tasks, which may be writing, referencing, thinking, filing, and the like. Equipments used, such as typewriter, video display, keyboard, printer and so on, enclosure requirements, that is fully enclosed, semi-private or open, access requirements, that is need for user or group interaction or proximity, human factors requirements, such as ease of use, flexibility of components, and others and qualitative requirements like the materials used according to the status of the worker. According to these
informations three general types of workstations may be designed. Individual workstations are designed to suit the specific functions and needs of each user. Group workstations are those designed for individuals working together or sharing equipments and materials. Special workstations are designed for special functions like those used as conference areas, rest rooms and reception spaces. Of course not all of the workstations in these group will be the same and there will be many differences in size, materials used, number of components and configuration according to the tasks done, status of the worker, the number of visitors, and still there are a lot of factors which affect the characteristics of the workstation.
4. GENERAL CRITERIA FOR DESIGN OF OFFICE FURNITURE

General criteria for design of office furniture systems can be classified into six main categories. These are as follows:

4.1. Basic Requirements

Flexibility; Since technological changes in our age are so unpredictable and fast, the furniture used in the office should be flexible enough to adapt in shape, size and total configuration with these changes. To achieve this aim, the furniture system should have the capacity of expansion, contraction and mobility of components. Any component should be easily adjustable in height and angle to suit the comfort requirements of any operator as well as the demands of the equipments. In addition any part of the system should be made of interchangeable and compatible standard modules, so that it can be dismount and reassemble to serve specific requirements of the equipments and the tasks. This allows for more planning flexibility and more efficient layouts. To be able to dismount and reassemble the parts quickly, any item of furniture should be light and easily movable without special tools and mechanically simple. Besides, the construction and materials of the components should be
durable enough to bear all these assemblies and disassemblies.

Simplicity; An automated workstation should be able to satisfy functional requirements with a minimum number of components, because the complexity in design of the elements of the workstation leads to usage and inventory problems. The fewer the parts, the fewer tools required to install and change the workstation and the simpler and more easily usable it will be. Furthermore, using less number of components, prevents creation of a crowded space.

4.2. Functional Requirements

Accommodation; An automated workstation should be able to accommodate video display monitors, keyboards, separate disk drives or other necessary electronic tools as well as conventional equipments. Furthermore, sufficient reference space for reference materials should be provided. Adequate storage and filing components, such as trays, compartments,...must be provided also.

Stability; The material and construction of the workstation components should be able to withstand heavy equipment loads. They must be rigid enough so that do not tip forward when are loaded and prevent vibration when machines work.
Ease of movement; In arrangement of a workstation, all primary tasks and equipment have to be located within immediate reach of the user and smooth movement of the operator between adjacent tasks and equipments should be possible. All other functional needs such as storage and displays have to be also easy to reach.

Ease of movement on the carpet; When the office floor is covered with carpet, the casters and glides of the furniture and equipments have to be over-sized to permit easy use of them on the carpet.

4.3. Health/safety Requirements

Fire Treatment; The materials used in an automated workstation should be fire-proof to reduce the risk of fire to minimum. The fire ratings of the panels and connectors must be checked by experts and special attention should be paid to materials that may burn or smoulder in a way that produce flame or toxic fumes.

Concealing wires; Any wire and cable in the workstation should be concealed to prevent falling down of the people and the risk of fire.

Round edges; The edges of the desks, file carts,... must be smooth and rounded to prevent injury to the people and
clothing.

Balance of the Panels; The feet of the visual aid boards and acoustical panels should be long, thin and narrow to prevent them from tipping and to prevent the individuals from tripping over the feet.

Electro-static materials; Heating and air conditioning systems generally have a drying effect on the environment by reducing the moisture content in the air. Humidity levels less than 40 percent can promote the build up or static electricity. These electrical charges can be generated and stored on surrounding objects. When discharged through contact with the objects or another person, they can be extremely annoying and detrimental to the health and comfort. Anti-static carpet and upholstery fabrics can eliminate much of the static discharge problem encountered in such an office environment (Pulgram and Stonis, 1984).

Humidity control; Most of the natural material such as wood, wool and cotton when used in interior spaces, help in balancing the humidity levels naturally. When covered with paint, polyester, and metal, these materials lose this quality. Since in a lot of today offices environmental conditions are controlled artificially and no natural ventilation is possible, the choice of material for office furniture becomes extremely important. When the
humidity percentage is not balanced naturally, bacteria and microorganisms may increase in the office environment and it results in an increase in physical discomforts. Therefore, it is wise to use natural material in office furniture design (Akman, 1991).

Protection from toxic fumes; Some kinds of synthetic adhesives used in producing chipboard plates and veneers which are often used in production of office furniture items, contain phenol or formaldehyde. The gases which are produced by these materials when distributed into the space, have negative effects on health. These materials also exist in some kinds of polishes, plastics and water-proof materials. When choosing material for producing office furniture, mentioned factors should be considered and materials which do not produce harmful fumes and gases should be preferred (Akman, 1991).

4.4. Maintenance

Ease of cleaning; The materials used in office furniture should be easily cleaned. File carts, drawers,... must have adequate floor-clearance for the same reason.

Ease of repairment; The components of the workstation should be easily replaced in case of damage without need for dismounting the whole parts. Easy access to cable-
management system inside the panels or other furniture items should be possible and the components should be easily moved for under-floor maintenance.

Durability; Materials used in different items of furniture like desks and panels should be stain, heat and scratch resistant.

4.5. Environmental Requirements

Sound control; Acoustical evaluation of the materials, surfaces and panels is necessary. Pulgram and Stonis (1984) state that chairs cushions of fabric blends nylon/cotton or wool are less sound reflective than plastic covers. They recommend basket or twill weave construction over loose or looped construction weaves for sound absorbent qualities. Acoustical treatment of the panels is also very important. Not all panels used in an open office are acoustically effective. There are different kinds of panels used. Some have hard surfaces made of steel, wood, glass or plastics which are sound reflective. Some of the panels are only partially acoustically effective. Examples of this kind are those made up of particle board wrapped in fabric and those which are made of particle board wrapped in fabric with an acoustic installation between. The most effective ones are those composed of a cardboard honey comb system wrapped in
fabric that work on the same principle as double walls, creating an air space to reduce sound transmission (Anderson 1988). Use of the latter type is recommended in office to control the acoustical environment. In addition to the mentioned points, in open-plan office, furniture should have minimum sound-reflecting vertical surfaces.

Non-reflecting surfaces; Surfaces of big items in the office should have not light reflecting (matte) finishings to reduce eye strains.

4.6. Aesthetic Requirements

In an automated office where tasks demands often place a lot of physical and psychological stress on the users, the importance of a visually pleasant environment is significant. To obtain visual interest followings are some hints:

Variation in finishings; There should be a variety of surface finishings, colors, materials and textures to avoid creating a monotonous space.

Distribution and balance of forms and colors; Workstations and other physical components of the environment which have different colors and forms should be distributed
through the office in a way that visual balance is obtained.

Variety in panel heights; It is necessary to use panels with different heights in the office to prevent the creation of a visual plane between floor and ceiling and a maze-effect.
5. ERGONOMIC CONSIDERATIONS

Ergonomics can be defined as the study of man in a working environment (Murrell, 1975). The term environment, in fact, consists of the ambient environment in which a person works, as well as his tools and materials, his method of work and the organization of his work, either as an individual or within a working group. All these are related to the nature of man himself; to his abilities, capacities and limitations. Ergonomics is an interdisciplinary field, drawing from physiology, anthropometry, psychology, engineering, management, design and many others. Ergonomic research analyzes the points of interaction between people and their work. It studies the effects of the space and work conditions on the human being and then redesigns the space and the work conditions to better fit the worker's physical and psychological nature.

In design of automated office furniture, ergonomic considerations become specially very important as many of the VDT (Visual Display Terminal) operators are tied to a man-machine system and have to work with a VDT for several hours without interruption, their movements are restricted, attention is concentrated on the screen and the hands are linked to the keyboard. In this situation
the support the work-station gives to the person's body and work becomes very important and the ergonomic shortcomings affect people seriously.

From the point of view of ergonomics it is possible to distinguish five kinds of jobs in an automated office according to the kind of interaction with the VDT, the requirements of the task done and the user needs. These are:

1- Data entry work;
2- Data acquisition
3- Conversational or interactive communication;
4- Word processing;
5- Computer-aided design (CAD) or Computer aided manufacturing (CAM) (Smith 1984, p.105 and Grandjean 1987, p.6).

Data Entry It is a repetitive and monotonous work. The operator's gaze is mainly directed towards the source documents and the eyes focus on the text of the source document. Constrained postures are frequently observed in this kind of job.

Data Acquisition (Data inquiry): Involves calling up information from the computer and reading it from the display. Attention is directed to the screen and sometimes also to the keyboard and the source documents. Most of the
working hours is spent looking at the screen.

Conversational Tasks (Interactive Jobs): Includes both data entry and acquisition but in this issue the data are generally more complicated. The gaze of the operator alternates between the source document and the display.

Word processing: Text entry, text recall, controlling text for errors, keying in corrections and designing the layout are the activities which are involved in word processing. In this kind of work operator should look at the screen for a longer period of working time.

CAD and CAM: These techniques are used for engineering and architectural purposes. At the design terminal, the designer or engineer develops a product. The result can be monitored on a graphic video display or may be plotted on a paper. The basic elements of a workstation using CAD or CAM programs are a graphic display, a digitizer, a tablet with a pen, or a mouse as a cursor control and an alphanumeric keyboard used as a data or command entry device. The works' characteristics are very similar to conversational tasks and the worker's control over the job is great.

Different ergonomic considerations may be more important for certain kinds of work, depending on the time spent looking at the screen, the nature of the work, and so on.
But there are general ergonomic requirements which should be considered while designing furniture items for all mentioned tasks. These requirements will be discussed in the following parts, while some specific criteria for design and arrangement of workstation for these specific tasks will be mentioned.

Two major groups of physical complaints observed in computerized offices are postural difficulties and eye problems (Schwartz, 1989). These complaints are in most of the cases, related to the poor design of the furniture. Thus, these problems are discussed in this chapter briefly and the criteria for designing proper furniture are given.

5.1. Postural Considerations

Posture is determined by the relationship between the dimensions of the workstation and those of the user. Therefore the position of trunk, head and the limbs and their relationships are the crucial issues to be discussed. This can be expressed by the angles at major joints of the body (Asatekin, 1975).

A lot of painful troubles in musculoskeletal system are associated with posture and the reason for many of the pains which are felt in different parts of the body when assuming certain postures are related to the muscular
loads in those parts.

There are two kinds of muscular effort: dynamic muscular work, and static effort. Dynamic effort is characterized by alternation between contraction and relaxation. Static muscular work is characterized by a prolonged state of contraction and usually occurs as a result of constrained posture. During dynamic work, blood flows, muscles' cells receive sugar and oxygen and the waste is removed. In static work, there is no flow of blood, so, the cells use their reserves, waste products can not be removed and this produces the acute pain of muscular fatigue. Constrained postures are the most frequent form of static muscular work. These constrained postures are usually caused by carrying the trunk, head or limbs in unnatural positions.

In computerized offices which workers are forced to work for long times with machines without moving and when there is a restriction of space for physical activities, constrained postures and muscular pains resulted from them are seen frequently. This is specially observed in the offices where improper furniture for different tasks are used.

Another part of the body which is susceptible to postural stress is the spine. Between each adjacent pair of vertebrae lies an intervertebral disk. These disks act as shock absorbers. In standing position, the spine has a
lordosis (concavity) in the lumbar region. When one leans forwards, this concavity flattens and may even be reversed. This leads to the deformation of the disks which results in back pain in the short-run and disk degeneration in the long-run.

Pheasant (1988) lists some guidelines to avoid prolonged static muscular loading as follows:

1- Encourage frequent changes of posture,
2- Avoid forward inclination of the head or trunk,
3- Avoid causing the upper limbs to be held in a raised position,
4- Avoid twisted and asymmetrical positions,
5- Avoid postures which require a joint to be used for long periods at the limit of its range of motion,
6- Provide adequate back support in all seats,
7- Where muscular force must be exerted the limbs should be in a position of greatest strength,
8- When the weight of the body must be supported avoid the build up of pressure on sensitive areas of tissue (p.153-4).

Özkan (1991) who conducted a study in 320 bank offices in Turkey, reports that the most observed health complaints of workers could be listed as: back pains 52.5%, neck and
shoulder pains 48.75%, headache 48.44%, nervousness 46.56%, wrist pain 39.68%,...Studies made by Grandjean (1987) and Smith (1984) also confirm these results. Smith (1984) besides, states that "the employee complaints in automated offices are ranging from back pain to sore neck to wrist and finger soreness" (p.99). He adds that these complaints could be related to the poor posture due to improper seating or incorrect visual viewing distance or angle.

Grandjean (1987) reports that physical discomfort in the neck-shoulder-arm-hand are particularly seen among the users of VDTs. He also mentions that in jobs involving repetitive work on machines the incidence of this kind of discomfort is high. He reports that physical discomfort in this region may increase when:

1- The keyboard level above the floor is too low,
2- Forearms and wrists can not rest on an adequate support,
3- The keyboard level above the desk is too high,
4- Operators have a marked head inclination,
5- Operators adopt a slanting position of the thighs under the table due to insufficient space for the legs,
6- Operators disclose a marked lateral abduction of the hands when operating the keyboard (p. 110).
The workstation can be a significant factor contributing to both visual and muscular health complaints because the height of working surfaces has an impact on the height of arms, wrists and hands as well as wrist and neck angles. On the other hand, the height of chair and the amount of support that it provides for the lumbar region has a direct relation with the worker muscular complaints.

5.1.1. Recommended Postures

There are two different theories about the recommended position of the human body while working with the VDT and the support given to the body by the workstation and the chair:

According to Kroemer (cited in Dainoff, 1984) and Çakır (cited in Pheasant, 1988), a specific physical support in the lumbar region is necessary. This lumbar support pad should force the spine into a lordatic posture when the worker leans against it. This lumbar support may be used alone or in a full-size backrest. Moreover, the seat pad height is recommended to be adjusted such that thigh-leg angles become approximately 90 degrees. The suggested angle of trunk and thigh is equal or greater than 90 degrees. The height of the work surface should be adjusted so that the elbow can be located at the keyboard height and the forearms become parallel to the floor and the
screen a little below eye level.

On the other hand, Grandjean and his colleagues' theory is based on the observation of posture assumed by users of VDTs in offices as well as experiments done in the laboratory. They observed that VDT operators whose keyboards heights were higher than optimal (greater than 84 cm), reported fewer muscular complaints than those with lower keyboards. In addition, they noticed that most of the subjects did not adopt a standard upright posture, in spite of all recommendations. Instead, they tended to tilt their adjustable back-rest towards the rear, lean back, and raise their forearms upwards. Average trunk inclinations were seen to be between 100 to 110 degrees, with average elbow angle at 99 degrees, the upper arm at 113 degrees and the forearm inclined upward by 14 degrees. This was equivalent to a vertical distance at approximately 10-12 cm between elbow and fingertips (Grandjean, 1983). This situation was the standard posture rotated backwards about 15 degrees. This situation was facilitated by the availability of adjustable chairs with full back-rests, adjustable keyboard heights, and arm-rests in front of the keyboard for further support. According to Keegan, "the most natural curve of the lumber area happens when the trunk-thigh angle is 135 degrees. This posture is assumed when lying or sitting on a chair with thighs moved forward" (Keegan cited in Asatekin, 1975, p.58). It seems that the feeling of comfort in the
mentioned situation is due to the trunk-thigh angle that approaches the Keegan's normal of 135 degrees and to the wider area on which the back is supported. This theory is confirmed by experiments done by a Swedish group of orthopedists named Nachemson and Anderson and other experiments conducted by Maguchi and his colleagues which measured the pressure inside intervertebral discs as well as the electric activity of the back muscles in relation to different sitting postures. They observed that when the back-rest angle increases from 90 degrees to 110 degrees, the intervertebral disc pressure and electromyographic activity of the back muscles decrease significantly (Dainoff, 1984). Figure 5.1 demonstrates these two approaches.

![Figure 5.1](image)

**Figure 5.1**

Recommended postures for VDT users by Grandjean (left) and Çakır (right)

A positive point about this posture is that it increases
the distance between the user and the screen. Although in many of the documents, it has been claimed that radiation emitted from VDTs has no adverse effect on the users' health (Grandjean 1987 and Pheasant 1988), the results of some surveys conducted by General Council of Trade Unions in Japan about the pregnant women, have shown that those women who work for long times with VDT, may have some problems with pregnancy or labour (Pheasant, 1988). The reason may not be the emitted radiation from the VDT, but the problem can not be ignored. In this case the posture recommended by Grandjean seems to decrease the risk to an extent. Moreover, as there are some reports about skin rashes on the faces and the hands of the VDT users, and since these may be related to the static electricity collected on the surface of the screen (Grandjean 1987), mentioned posture which increases the distance between the face of the user and the screen may be recommended.

Actually sitting behaviors of the people are different. They sit with different postures such as formal posture, mid-way posture or backward posture (Erbug, 1987). They may sit as is recommended by the experts or not. Although the profile of the seat is a determinating factor in how people sit, they may and have to change their sitting posture in time. The important thing is that the back-rest should be completely adjustable to correct the defaults of the assumed sitting postures. In other words the back-rest should give adequate support at the correct level for any -
back-rest declination. "The lumbar support of the back-rest moves about 4.5 cm upwards when the inclination is increased from 90° to 105°. This corresponds to almost a whole lumbar vertebral segment" (Grandjean, 1987, p.134). Therefore, when in a normal chair the back-rest declines, the lumbar support does not remain in the correct level any more. Now "dynamic chairs" are going to solve this problem. Their working principle is based on that as the back-rest's declination increases, it descents. So the lumbar pad always gives support to the correct area. Figure 5.2 demonstrates an example of this kind of chair.

Figure 5.2
A dynamic chair (Source: Grandjean, 1987, p.134)

5.1.2. A different Approach to Seating

Another radical new approach to seating has been proposed by Mandal (cited in Pheasant, 1988). He argued that seat
surfaces should slope forwards, hence diminishing the need for hip flexion and encouraging lumbar lordosis (Pheasant 1988). The disadvantage of this chair is that when someone sits on the chair, one tends to exert a backward thrust with the feet in order to stay in the seat. This situation may cause some problems particularly when the chair is on castors and when there is a low friction between the outer and inner garments of women (in this case they tend to slide out of their skirts). These difficulties can be overcome by using kneeling chair which provides a seat sloping forward at some 30 degrees, combined with a padded support for the knees (Figure 5.3).

Figure 5.3
Forward slope and kneeling chairs

A problem of this kind of chair is that the load on the knees and lower legs is too high and sitting becomes painful after a while (Grandjean 1987). Moreover, entry and egress from this chair is quite difficult, and it is
especially a problem for people who perform tasks which require frequent movement of the user. According to the results of a study conducted by Drury and Francher (1985), workers using VDTs were rather uncomfortable with this chair, particularly in the leg region. For this group the overall discomfort has been quite high and it has become worse throughout the evaluation period. Grandjean (1987) also claims that:

> Overall the chair was no better than conventional chairs and could be worse than well-designed office seats (p.124).

So, Although these chairs exhibit an interesting approach to seating, they are not good alternatives to be used by the operators of the VDTs in the automated office.

5.1.3. Anthropometric Data

In the design of a workstation, several dimensions of body are necessary to be known. But there is a great variation in body size among individuals, between the two sexes and different ethnic groups. The science that deals with measuring size, weight and proportions of the human body is anthropometry. Anthropometric research allows designers to predict the human reach and space requirements for different activities and to assess principles for the design of suitable dimensions of workstations.
Anthropometric data relevant to the design of the office workstations are listed in table 5.1 and exhibited in figure 5.3. According to these measurements, the dimensions and the range of adjustability for different items of furniture in the automated offices can be predicted.

It should be noticed that ergonomic recommendations for the dimensions of the workstations are not only based on anthropometric data but also on the behavioral patterns of employees, specific requirements of the work itself and the physical and mechanical limitations involved. "The range of adjustability should allow the design to accommodate at least 90 percent of the user population" (Panero and Zelnik, 1979, p.38).

Table 5.1 Anthropometric data relevant to design of office workstations:

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>Men 5%</th>
<th>Men 95%</th>
<th>Women 5%</th>
<th>Women 95%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stature</td>
<td>160.3</td>
<td>180.1</td>
<td>149.5</td>
<td>167.3</td>
</tr>
<tr>
<td>Sitting Height</td>
<td>83.2</td>
<td>94.5</td>
<td>78.7</td>
<td>87.1</td>
</tr>
<tr>
<td>Sitting Eye Height</td>
<td>72.3</td>
<td>84.0</td>
<td>68.6</td>
<td>76.7</td>
</tr>
<tr>
<td>Sitting Shoulder Height</td>
<td>55.1</td>
<td>65.8</td>
<td>53.0</td>
<td>59.5</td>
</tr>
<tr>
<td>Sitting Elbow Height</td>
<td>21.1</td>
<td>27.9</td>
<td>18.6</td>
<td>21.6</td>
</tr>
<tr>
<td>Sitting Knee Height</td>
<td>46.6</td>
<td>58.0</td>
<td>46.5</td>
<td>52.6</td>
</tr>
<tr>
<td>Elbow Fingertip Length</td>
<td>40.4</td>
<td>45.7</td>
<td>37.8</td>
<td>42.4</td>
</tr>
<tr>
<td>Buttock-Knee Length</td>
<td>51.9</td>
<td>61.2</td>
<td>51.6</td>
<td>57.4</td>
</tr>
<tr>
<td>Buttock-Popliteal Length</td>
<td>43.2</td>
<td>49.3</td>
<td>40.1</td>
<td>46.0</td>
</tr>
<tr>
<td>Popliteal Height</td>
<td>37.8</td>
<td>45.5</td>
<td>36.6</td>
<td>41.1</td>
</tr>
<tr>
<td>Thigh Thickness</td>
<td>11.4</td>
<td>17.3</td>
<td>13.2</td>
<td>15.7</td>
</tr>
<tr>
<td>Hip Breadth</td>
<td>29.9</td>
<td>36.4</td>
<td>31.5</td>
<td>40.9</td>
</tr>
<tr>
<td>Shoulder Breadth</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 5.1 (con'd)

<p>| | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(Biacromial)</td>
<td>39.4</td>
<td>53.1</td>
<td>33.0</td>
<td>38.0</td>
<td></td>
</tr>
<tr>
<td>Shoulder Breadth</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Bideltoid)</td>
<td>45.5</td>
<td>60.9</td>
<td>36.0</td>
<td>41.0</td>
<td></td>
</tr>
<tr>
<td>Easy High Reach</td>
<td>178.6</td>
<td>200.4</td>
<td>166.4</td>
<td>187.2</td>
<td></td>
</tr>
<tr>
<td>Easy Down Reach</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Standing)</td>
<td>67.6</td>
<td>77.7</td>
<td>63.0</td>
<td>70.8</td>
<td></td>
</tr>
</tbody>
</table>

Body dimensions for Turkish male population are taken from Kayış (1989), and data corresponding to the Turkish female are derived by the author, using stature dimensions given by Demirkan (1991).

Figure 5.4 Demonstrates these anthropometric dimensions.

5.1.4. Work Surface Height

The dimensions mentioned in the following parts, which are taken from the other sources are controlled and tested with above dimensions to be the proper dimensions for Turkish people.

5.1.4.1 Work Surface Height for Manual Tasks

The most critical ergonomic measurement to consider in the design of a workstation is the work surface height. If the work surface is too high, the user's shoulders and forearms should be raised to compensate it and the result is pain in this area. If the work surface is too low, the
Figure 5.4

Anthropometric Dimensions
result will be a back and a neck ache for the tall people since they should bend the neck over the work table (Wierenga 1985, Grandjean 1987 and Pheasant 1988). Hence, in design of tables which are not adjustable and the height is primarily based on the average body measurements, and there is no allowance for individual variations, the work height may be chosen to suit the tall rather than the short person. A foot-rest may be given to the short person so that he/she can adjust the seat to a suitable level. Grandjean (1987) suggests a height of 74-78 cm for men and 70-74 cm for women assuming that the chair is fully adjustable and a foot-rest is available for the office desks used for traditional tasks. A maximum height of 76.7 cm is recommended for Turkish male population for the same purpose.

1.3.2 Keyboard Height

The correct working height for using keyboard can be derived from proper arm placement. The height of the keyboard should allow the worker to assume a correct position of working with least static load on his/her muscles. Since these heights vary considerably depending upon the body proportions of the user and thickness of the keyboard, use of a height-adjustable work surface or dropped keyboard tray which can be adjusted horizontally and vertically is recommended.
Grandjean (1987) states that a proper VDT workstation should be adjustable in the following dimensions:

- Keyboard height (floor to home row) 70-85 cm
- Screen center above floor 90-115 cm
- Screen inclination to horizontal \(0^\circ-10^\circ\)
- Keyboard (home row) to table edge 10-26 cm
- Screen distance to table edge 50-75 cm

(p. 149)

The controls for adjusting the dimensions should be easy to handle from a seated position, especially when more than one person may work at the workstation during a day.

Another important factor in determining the height of the work surface is that a sufficient clearance for the legs should be provided under the table. Pheasant (1988) states that "the lateral legroom should give clearance for the thighs and knees" (p.184). Besides, it should allow for comfortable lateral movement of the thighs. Grandjean (1987) mentions that the legroom under the table should be at least 68 cm wide. Vertical legroom can be determined by the knee height of the tall user. Grandjean (1987) suggests a 69 cm high legroom. Özkan (1991) recommends 68 cm for the same purpose. The important factor to be considered in determining the height of the legroom is
that a 17-20 cm clearance should be provided between the surface of the seat and the lower edge of the table. For this reason no drawer should be designed above the knees. The forward legroom is determined by buttock-knee length minus abdominal depth which is something around 42.5 cm from the table's edge at knee level and at least 57.5 cm at the level of the feet (Pheasant, 1988). Therefore, Grandjean (1987) suggests a 60 cm deep legroom in the level of knees and 80 cm in the level of feet.

In any workstation, surfaces for reference materials, taking phone messages and many other non-VDT functions should also be provided. If manual tasks, specially writing are also done on the work surface, additional surface for them would be necessary, since the proper height for keyboard may not be suitable for writing tasks. Using a bi-level height adjustable work surface such as a desk with a keyboard tray and additional surface for the display which can be adjusted partially, may be a solution for holding the VDT on an upper level and the keyboard at a lower one.

5.1.4.3. Work Surface Height for Peripheral Equipments

In addition to the keyboard and the VDT, some tasks may also require using other peripheral equipments such as separate disk drives, printers, modems, faxes, etc..
Secondary work surfaces should be prepared for these equipments. Some work surfaces may be used from a seated position and the others from a standing position. For the wall-hung credenza and secondary work surfaces used for peripheral equipments a 71-76 cm height which can be reached easily from a seating position is proper (Panero and Zelnik, 1979).

5.1.4.4. Storage and File Cabinet Heights

Shelves and Files are also of two kinds, those which are used from a sitting position and those used from a standing position. All 'over table' storage and shelving should be within the easy reach from a seated position. A 135-147 cm height is suitable for this kind of vertical storage. A minimum distance of 38cm should be provided between the surface of the work surface and the lower part of the vertical storage. The height of the shelves which are used from a standing position have to be determined so that can be reached by shorter people easily. A maximum 175.5 cm height is adequate for this kind of shelves (Panero and Zelnik, 1979).

The other components used in an automated workstation are file drawers. There are two kinds of file drawers. Those which are used from a sitting position has a height equal to those of the wall-hanging credenza. The height of the
files used while standing, should be about 137-147 cm (Panero and Zelnik, 1979).

5.1.4.5. High Counter’s Height

Sometimes, high counters are used in offices for visiting costumers. The height of this kind of counter can be between 86.5 and 99 cm and the user should be provided with a high chair with adjustable height and a foot-rest (Panero and Zelnik, 1979).

It should be noticed that designing height adjustable shelves and vertical storages makes use of these items much more comfortable for the users.

5.1.5. Width and Depth of the Work Surfaces and Horizontal Clearances

Pulgram and Stonis (1984) suggest a width of 114 to 183 cm and a depth of 76 cm for the rectangular primary and secondary work surfaces to accommodate most electronic equipment and support functions, yet shallow enough to make easy reach and access to peripheral equipment possible. In addition, while arranging these work surfaces within the workstation, it is important to set up them in a way that convenient movement between equipments, work table and file/storage elements be possible. A 122-173 cm
zone should be provided between the edge of the table and the file cabinet if the file cabinet is going to be used by the user from a seated position rotating 180 degrees. A 45.5-66 cm distance in front of the file cabinets is necessary for the file drawer extension zone (Panero and Zelnik, 1979).

5.1.6. Chair

In choosing a chair for the automated workstation, the primary objective is the personal comfort. The proper chair is a combination of construction materials, dimensional criteria and adjustment features which have been designed and integrated according to the anatomical and biomechanical structure of the body.

The most important factor which should be considered when designing or choosing of the proper chair for automated workstation is adjustability. This allows the user to fit the chair in a variety of positions to obtain the most comfortable situation for any task. Tilt mechanisms in an office chair provide angle adjustments for the seat and back, swivel mechanisms allow smooth lateral movement and pneumatic devices make automatic height adjustment possible. Attaching castors to the base is also necessary to provide ease of movement. Adjustable arm rests may be used to reduce arm and shoulder fatigue in the jobs which
require long periods of VDT interface. All these adjustability controls should be user-friendly designed and easy to use from a sitting position.

Other very important criteria in choosing an office chair are the support it gives to the body and the way it distributes the weight. A proper chair should allow the body weight to be carried primarily by the bony structures of the buttocks, to reduce the stress and pressure on the back and leg muscles. Moreover, the nature of automated tasks require that a chair design provide continuing support for the body. This support is mainly achieved through proper seat and back contouring as well as the internal construction materials. Contouring means smooth upwards and outwards curvings at the sides, front and back, top and bottom of the seat and back cushions which contributes to the distribution of the weight of the body and provides lateral back and thigh support.

The material used in cushioning and covering the chair should allow an air circulation over the skin surface and should have some humidity absorbing capacity to prevent condensation of moisture produced by the skin evaporation. Furthermore, these materials should have enough thermal diffusivity properties suitable to give a warm touch. The texture of the covering material should provide a suitable friction to prevent sliding out of the chair. A padding of
foam rubber 2 cm thick, covered with non-slip, permeable material can be a great aid to comfort (Grandjean, 1987).

The front edge of the chair should be rounded, so that underthigh tissues compression and the pressure on the blood vessels and nerves can be prevented.

The seat properties should allow sitter to change his posture during sitting. A change in position from leaning back to leaning forward should be possible for the user. An ergonomical chair should allow the back to get adequate support at the correct level for any back-rest declination.

5.1.6.1. Back-Rest

The back-rest should specially support the back at the lumbar area. This support is named as "lumbar pad". The shape of this lumbar pad should encourage a lordosis, so it should have a convex curve in the vertical section. When the back-rest inclination increases beyond 105 degrees it should also support the thoracic region (the upper part of vertebrae) (Asatekin, 1975). The center of the lumbar pad is usually recommended to be 10-20 cm above the seat surface. Grandjean recommends a horizontal curvature with radius of 45 cm at lumbar pad and 65 cm at shoulder height for the back-rest. Barkla recommends a
general 80 cm radius for the same curvature. (Grandjean and Barkla, cited in Asatekin, 1975). Between the lumbar-pad and seat, enough space for sacral protrusion (the lower part of the vertebrae) should be provided to obtain a proper contact between the lumbar pad and the lumbar area. Moreover a well designed back-rest should support part of the weight of the trunk and reduce the mechanical loading on the spine. This effect increases with the rake angle of the back-rest. Thus, the back-rest should have an adjustable inclination which can be locked at any desired inclined. Grandjean (1987) declares that a back-rest height of 48-52 cm vertically above the seat surface is an ergonomic necessity today. He also advises a width of 32-36 cm for the back-rest.

5.1.6.2. Seat Depth

Seat depth should be less than buttock-popliteal length so that the user can engage the backrest easily without feeling extra pressure on the backs of the knees. Moreover, a deep seat make standing up and sitting down more difficult for the user. A seat depth of 38-42 cm is recommended by Grandjean (1987).

5.1.6.3. Seat Width

Seat width may be determined by using the maximum breadth
of the hips. Pheasant (1988) suggests a width which is some 25 mm less on either side than the maximum breadth of the hips. That is a minimum of about 500 mm considering clothing. According to Grandjean (1987), 40-45 cm measurement is enough for the same purpose.

5.1.6.4. Seat Height

The correct seat-height is to be determined by the popliteal height. In most of the cases a height close to the popliteal height is optimal. When the height increases, considerable discomfort may be felt. As the height decreases, standing up and sitting down become more difficult and greater legroom is needed. A height adjustability range between 38 and 54 cm is offered by Grandjean (1987) to give an opportunity to a wide range of the users to fit the chair in a suitable height for themselves.

5.1.6.5. Tilt of the Seat

Tilting the seat surface slightly backwards prevents user to slide forward and helps discs to obtain a neutral position (Asatekin, 1975). A seat inclination around 7 degrees is recommended for straight chairs.
5.1.6.6. Arm-Rest

Arm-rests, when used, should not cause raised shoulders or any position which induces muscular activity. Besides, they should not restrict the movements required by the task. The height of the arm-rest is derived from the sitting elbow rest height. Asatekin (1975) suggests a height of 22.4 cm for arm-rest for Turkish population.

Figure 5.5
Profile of a multi-purpose chair
Grid: 10*10 cm
(Source: Grandjean, 1987, p.130)

5.1.7. Complementary Devices

5.1.7.1. Foot-Rest

A foot-rest should always be provided, since when the work surface height is stationary, adjusting the seat
height to achieve a correct typing and viewing position may prevent the feet of shorter people from resting comfortably on the floor. This foot-rest may have 10-25 degrees angle with the ground but adjustability of height and angle is a desirable feature of the foot rest.

5.1.7.2. Palm-Rest (Wrist-Rest)

Using a support for forearms and wrists makes usage of the keyboard a lot more comfortable and reduces the physical complaints in this region to a great extent since the unsupported wrist and palm can cause muscular fatigue in the arm and shoulders. Palm-rest is an accessory put in front of the keyboard to provide a surface on which palms can rest.

5.1.7.3. Document Holder

A document holder can be used when the task requires frequent use of reference materials. When the focal distances between the document and the screen are different, the eyes should continuously accommodate to each distance which causes eye strain. Moreover, the movement required when looking back and forth between the source document and VDT creates a stress on the neck muscles. Use of a document holder may reduce the head
inclination angle and prevent the neck muscles to assume a constrained posture. The Document holder should be placed on the same plane and viewing angle with the display screen. So it should be adjustable to be set in a position which is suitable for the user. The size of the document holder should allow the accommodation of computer print outs as well as standard size papers and other reference materials.

5.1.8. Different Recommendations for Different Jobs

Followings are some guidelines for arrangement of work surface for different tasks:

For data entry tasks, keyboard and a document holder should be positioned in front of the operator and the screen to the side, as the keyboard and documents are used continuously and screen occasionally. For this kind of tasks adjustability is a primary consideration because there is a great load on the back and shoulders of the user. Therefore, it is important to provide a good chair, an adjustable keyboard, and a proper surface for source documents (Smith, 1984). A wrist-rest can make this job a lot more comfortable.

In conversational (interactive) tasks, as well as data acquisition and word processing, the eyes mainly alternate between source documents and the screen while both hands
operate the keyboard. For this kind of work, a frontal arrangement of all three elements is possible, but when the document is large, it should be placed on the left of the keyboard. Environmental factors such as glare control, lighting and viewing distance are very important in these sorts of job. Wrist-rest, adjustable chair and screen height should be provided.

5.2. Visual Considerations

According to Wierenga (1985) visual discomfort is a major source of irritation for workers in VDT environment. Galitz (1984) states that:

The most commonly reported visual discomfors in automated offices are: eye strain, burning and/or irritated eyes and blurred or double vision. Dainoff et al. (1981) found a moderate but significant correlation between visual discomfors and time spent using the VDT (p.22).

Some others do not agree that working with VDT causes visual discomfors. Starr (1984) deduces from his studies that a VDT does not stress the visual system more than analogous near-vision work done without a VDT. The reason for a lot of visual problems seen in the automated offices explained by Collins, et.al.(1990) is that the line of sight for VDT use is inclined more towards the horizontal than it is for hard copy tasks performed at a desk. A
factor which may introduce glare sources such as windows and ceiling luminaires into the user's field of vision.

5.2.1. Glare

Glare, is produced by high luminance contrasts between the various surfaces in the visual field. It may be direct, as from a light source, may be a result of too-high contrast between the brightnesses of large objects in visual field (contrast glare), or may be caused by annoying reflections on the glass surface of the screen (reflected glare). It can result in eye fatigue because the eye should continually adapt between surfaces of extreme brightness contrasts, consequently it may cause headaches and decreased productivity.

Glare is often produced by the wrong placement of VDTs with related to potential glare sources such as windows and lights and inadequate lighting design as well as using unsuitable finishing and colors for the furnishing materials. To avoid glare, the large objects and major surfaces in the visual field should be equally bright. Reflecting table tops, bright walls contrasting with dark furniture should be avoided. In other words for walls and furnishings of the office unsaturated colors with matte finishes should be used. Light fixtures should be installed parallel to and on either sides of operator-
screen axis (Grandjean, 1987 and Pulgram and Stonis, 1984). In addition no light source should appear in the visual field of the workers. NYCOSH (New York committee for Occupational Health and Safety) recommends installing indirect lighting designed expressly for VDT work (NYCOSH cited in Wierenga, 1985).

5.2.2. Different Levels of Illumination

Another problem seen in automated offices is that VDT working environment needs a much lower level of illumination comparing to that needed for conventional office work. Wierenga (1985) states that the American National Standards Institute's recommendation for minimum illumination levels in a general office environment is nearly twice that recommended by some experts for offices using VDT. This difference between two levels of illumination is responsible for some incidences of glare.

Here it should be mentioned that visual discomforts observed in offices are reversible and not permanent eye injuries (Grandjean, 1987) but they make user feel uncomfortable and reduce his productivity. To cope with these problems (glare and different levels of illumination) a task light should be provided in any workstation. Task lighting is a lighting source that is focused upon, and illuminates a particular task or work
area. It may be positioned at the specific work surface or may be integrated into the workstation furnishings. Task lighting can be either flexible or fixed. Fixed systems are usually mounted to the underneath of the shelves. This kind of systems should be shielded with some devices to avoid reflected glare on the work surface. By using task lighting the operator can set her or his own level of light, required for specific task done. Adding a dimmer (control to adjust brightness of light) to task light provides even more control over the visual environment for the user.

Task lights especially when adjustable, have many advantages; they direct light towards the task and make it brighter than the background. They can be positioned to minimize glare and the intensity of light can be changed to match the worker's needs. In addition people who have problems with their eyes or older people whose visual acuity decrease with age can individually control the level of illumination. If the task light is going to be fixed in the furniture, it should be arranged so that the shadow of the operator does not cast on the work that he is processing.

Using task lighting, the ambient lighting throughout the building can be limited to the minimum necessary to create a pleasant appearance and safe movement about the
building.

Once more it should be emphasized that to reduce visual discomforts in offices, flexibility in terms of individual control should be provided in lighting design.

5.2.3. Location of VDTs in Relation to the User

The other category of visual considerations in automated offices are those which are very difficult to be distinguished from postural problems. These problems are generally related to placement of the display within the workstation. The visual demands of a task and the location of the display are important factors in determining the posture of the head and neck. It is the reason for difficulty in separation of some visual and postural considerations in automated office.

Two important ergonomic considerations which affect both visual and postural comfort of the VDT user are viewing distance and viewing angle.

5.2.3.1. Viewing Distance

Viewing distance, distance from the eye to the screen has usually a close relation with the size of the characters displayed on the screen. However, a range of 45 to 50 cm is recommended by Wierenga (1985). Pheasant (1988)
suggests an average visual distance of 76 cm. The best choice is to provide the workstations with displays that can be adjusted in different distances since very close visual works are fatiguing and lead to eye strain. The result may be blurring of vision, headache and burning of the eyes.

5.2.3.2. Viewing Angle

Viewing angle, the angle at which the operator views the screen also has an important impact on visual and postural comfort of the user.

When we look ahead, our eyes naturally assume a slight downward gaze of 15 degrees from the horizon line. This is called the relaxed line of sight. Regular viewing tasks should be within a 30 degrees cone around this line. For this reason, the display should be placed within a viewing angle of 5 degrees above and 30 degrees below the horizontal plane (Grandjean, 1987). Figure 5.4 demonstrates the normal line of sight and range of easy eye rotation.
the normal line of sight and the range of easy eye rotation
6. SOCIAL AND PSYCHOLOGICAL CONSIDERATIONS

Goodrich (1986) explains why attention should be paid to the "human logic" as well as "technologic" in designing the office of the future as:

The psychological dimension of office design becomes increasingly important as the office becomes more mechanized and places more demands upon the person’s mental and physical resources. The human dimension (high touch) is intimately connected with and impacted by the more complex physical and technical environment (high tech)... The new office should support and enhance its chief strategic resource — the brain power of its users (p.132).

The design of the office should support the work people do in the office. Work however is not only the specific task people perform in the workstation, but also the mental activities and operations required for doing that work (Sundstrom, 1986-b). Therefore, taking only a functional approach and design an environment which serves performing the required task, without any regard for the needs of the worker, may cause unwanted results such as stress, low morale, boredom and dissatisfaction of the user. So, a workstation should fit both the requirements of the task and those of the user.

Moreover, the designed environment affects the social
relations in an office. Goodrich (1986) mentions that the
designed environment influences our social relations in
different ways. It influences our contact with others, the
type of interaction, the amount and quality of interaction
and interaction process itself.

An arrangement of furniture may encourage employees to
work in groups or separately; may make user feel herself
or himself as a part of the company or not and still many
other influences of physical environment in general and
furniture as a very important part of it on social
relations and psychological condition of the workers can
be pointed out.

The relationship between a person and the workstation is
highly complex, since worker's comfort, satisfaction and
performance is related to a number of factors such as the
characteristics and activities of the occupant, the
details of the equipments and components of the
workstation, the task performed and the work habits and
the body dimensions of the worker. The two frequently used
terms when speaking about psychological condition of the
workers, job satisfaction and performance are described by
Sundstrom (1986-a) as:

The term job satisfaction refers to the
workers evaluation of his or her job as a
whole or of the general quality of life
at work. Job satisfaction represents an
amalgamation of many types of satisfaction, including satisfaction with the physical environment. The term job performance refers to the effectiveness with which the individual accomplishes assigned tasks, according to such criteria as quantity, quality or efficiency (p.4).

The physical environment may influence these factors through psychological processes. According to Sundstrom (1986-a), five psychological process through which physical environment affects the performance are: arousal, stress, distraction, overload and fatigue. Arousal (the general level of physiological and psychological excitation) changes as a result of physical stimuli such as heat and noise. These factors may raise the arousal level to an optimal level for performing the task or may affect performance negatively. Stress may occur in response to conditions which seem to be threatening to the individual's well being and it may result in arousal and narrowing of attention, which decrease the performance. Distractions from the physical environment may lead to diversion of attention from the task or lead to overload of the individual's capacities. Overload of the capacities, which may be a result of stress or the requirements of the task, and mental fatigue usually happened as a consequence of poorly designed environment, also reduce the person's comfort and level of efficiency which in its turn leads to reduction of performance.
Actually, socio-psychological considerations in the design of the physical environment in general and furniture particularly, in an office can be analyzed in three levels. The first level is the effect of physical environment on the organization's life. The second level is its effect on inter-personal relationships and the third is the effect on the individual worker. In fact these three levels can not be separated by a line. These are very closely related to each other as without individuals there would be no interpersonal relationships and these are in their turn the basic elements of an organization. Therefore, very often the concepts related to one level is also appeared in the others.

6.1. Organization's Structure

The relation of furniture with the organizational needs is described in chapter 3. Beside that, furniture has an important role in the social life of an organization. In this section this aspect of furniture design is studied.

6.1.1. Conveying Messages

An important function of physical setting including furniture in an organizations is that it carries messages about character and values of the organization and its identity to both its staff and to the public. The physical
setting in an office gives information about its culture and how its management views the workers and the tasks they perform. For instance the sizes, number and arrangement of furniture components in workplaces and characteristics of lighting, level of sound, degree of privacy and control over environment and many other factors may give messages about the roles of individuals within the organization. Something important to be stated here is that the mentioned factors not only exhibit to customers from the outside world about the way an organization sees its employees but also the workers of the office perceive the importance of their roles and those of the others in the office using these factors.

Another important design feature which gives clues about the culture of an organization is the type of planning selected for the office and the way the workstations are arranged. The type of planning shows the degree of respect in the organization for different ranks. How formalized or decentralized an organization is, how complex the hierarchy is and how strongly status is emphasized can be observed through the type of planning in the office and through the differences between the workstations (or lack of differences).

The selection of planning type, spatial organization and furniture for an office should always be appropriate with
its identity and culture. For instance using high-tech furniture in a bank office that wants to give an image of a "noble" organization to its customers may not be very wise. On the other hand, using classic, heavy looking furniture for an organization which is going to produce an image of a young, dynamic organization or for a company which produces a high-tech product such as computer games, seems to be a big mistake.

Thus, before choosing or designing a furniture system, the designer should know about the culture of the client company, how it treats its workers' ranks and the image it wants to create of itself in its customers and workers' minds.

6.1.2. Hierarchy and Status

Another aspect of organizational life which directly affects the selection of furniture and its configuration is the concept of status. Status is defined by Konar and Sundstrom (1986) as "the value placed on an individual in comparison to the other individuals" (p.203). It is a very important factor to be considered in the design of an office interior. However, the degree of importance of this concept in an organization is decided by its management.

Although the approach of "office landscape" originators to
office design encouraged the removal of status markers from the workplace, it does not usually fit with the goals and realities of the organization. Therefore, in design of an open-plan office, a balance between status ranking and "democracy" should be caught and the designer and management should agree about how rigid, organized and visible the display of status is to be in the office installation (Pile, 1978). The level and ways of displaying status may change in different organizations, but it seems that it is an important factor in satisfaction of the workers. According to the theory of status congruency, developed by Stewart Adams in 1953 (cited in Sundstrom, 1986-a), any worker experiences satisfaction when status markers agree with rank. On the other hand, a workspace that seems inappropriate for the rank in the hierarchy may create dissatisfaction and discontent. Erdemir (1979) states that status is an important factor in the life of Turkish society and that the most significant reactions against the open office will be from those with upper ranks in the organizations. He adds that any plan of this kind in Turkey should give opportunity to the management for adding some additional partitions later.

Generally there are two ways of demonstrating status in an organization: Material status and social status. Material status is determined by having things that people from a lower rank do not, like luxury furniture, a bigger space
than other's,... Social status is more often marked by freedom to do things that others can not or difficulty to access, and it is mainly determined by technical value or the importance of the job one does in the technical structure or social value gained by the level of education and seniority.

The status of a worker in an organization is usually indicated by the nature of his or her workplace. This process of using physical setting to determine the status of an individual in an organization is called status demarcation and status markers are factors used in status demarcation. The most important traditional status markers can be listed as:

- Location; the location of work place in the building is generally related with the rank. Location of the workstations of people with higher ranks near the windows and in the corners in open plan offices, and their private offices in higher floors are examples of this.

- Accessibility; the higher the rank, the less accessibility. Usually the workers with higher status have more control over the access. In open-plan offices this factor is emphasized by the level of enclosure of the workspace.
Floor space; In most of the organizations the floor space used by workers changes with their ranks. The bigger the workplace the higher the rank.

Furnishing; Desks, chairs, cabinets, etc. are made in a variety of sizes, materials and styles. These variations are usually used in relation with status. For instance, the desks and chairs of people who have higher status in an organization are usually bigger and made of more expensive materials comparing to the ones belonged to the others. Also the variety of furniture components used in a workplace generally increases with status of the user. In many cases the degree of variation is only determined by the status of an individual and may not fit the functional requirements of the tasks he or she does and the characteristics of him or her.

Personalization; Usually more freedom to personalize the workplace is given to those with higher status in organizations by giving opportunity of choosing the furniture and other components of workplace and their arrangement. The concept of personalization will be discussed in more detail in the following parts.

Extra facilities; Having extra facilities like high-tech facilities (facsimiles, telephones with complementary functions, etc.) is often proportional with the status.
6.2. Interpersonal Relationships

Hall (1969) mentions that people (and actually all animals) generally manage their social relationships using four different classes of distances. These are intimate distance, personal distance, social distance and public distance, each with its close and far phases. Intimate distance is used in very close relationships between two persons. Personal distance is the distance a person uses when speaking with his or her friends and is a small protective sphere or bubble that one maintains between itself and the others. Social distance is the distance one uses in relation with others who are not friends of him or while doing a job or other similar activities. Public distance is assumed when one wants to be well outside the circle of involvement.

Usually, people in the office tend to achieve a far phase of social distance in relation to the others. Hall (1969) states that:

Desks in the offices of important people are large enough to hold visitors at the far phase of social distance. Even in an office with standard-size desks, the chair opposite is eight or nine feet away from the man behind the desk (p.122)

In this distance it is easier to maintain visual contact than it is in the closer distances and this factor is
usually very important in the conversations of any length. This proxemic behavior is culturally conditioned and is entirely arbitrary (Hall, 1969). Studies of people working in private offices also has shown that most of the workers place their desks in a way that divide the room to three zones, a personal work area behind the desk, a visitor area in front and a circulation/display area connecting the two (Goodrich, 1986). The aim of this configuration may also be to achieve the previously mentioned distance. Hall (1969) states that this distance (far phase of social distance) "can be used to insulate or screen people from each other. This distance make it possible for them to continue to work in the presence of another person without appearing to be rude" (p. 123).

In most system furnitures that work surfaces are attached to the partitions and there is a minimal space within the workstation, and no barrier is available between the worker and the visitors, this may cause some problems. The reason for this problem may be that the design of these workstations are done according to the actual physical dimensions of the individuals and the fact that "man has around him as extensions of his personality the zones described earlier " (Hall, 1969) is overlooked. To achieve a healthy relationship between the people in the office, the design of the workstations should be once more revised concerning these zones.
6.3. Individual Level

6.3.1. Space Perception

Studies of İmamoğlu (1973), have shown that there is an inverse relation between the furniture density in a space and the mean perceived size. It means that when a room is overfurnished it is perceived as smaller than its actual size. On the other hand, an overfurnished room (or workplace) seems to be less spacious (İmamoğlu, 1973). According to İmamoğlu (1986):

> For a room to be spacious, first of all, it must be appealing, then well planned and finally must have space freedom. On the other hand planning seems to be the most important factor for crampedness (p.132).

He adds that when a room is poorly planned, when it fails to satisfy the functional requirements, when its physical size is too small for a particular function, when it is cluttered that means that the number of people or the number of items in the space seem excessive, and finally when it looks unappealing, it is perceived as cramped. When an interior score high on crampedness scale, it fails in proper functioning. On the other hand, interiors with high values of spaciousness, not only fit functional and physical requirements but also give some emotional satisfaction or comfort to the occupants.
So, spaciousness is a concept that brings many important aspects of an interior together. It may be considered as a general evaluation scale for interior spaces. This concept is generally derived from visual perception of interior spaces and as mentioned before has a direct relationship with the density of the furniture within the space. İmamoğlu (1973) mentions that:

> It seems that there is an optimum level for the furniture density, when this density is exceeded, additional items start playing a negative role on people's feeling of spaciousness (p.350).

Thus, the amount of furniture used within a workstation and the configuration of them within the office, should be chosen in a way that the space is spacious and answers the physical needs of the users beside giving a sense of comfort to them.

6.3.2. Privacy and Territoriality

The term privacy usually refers to the management of information or the regulation of social interaction (Laufer, et.al., 1973 and Sundstrom 1986-b). In work environments, privacy usually connotes an intentional retreat from unwanted observation, audition, distraction, or interruption (Sundstrom, 1986-b). Laufer et.al. (1973) list three aspects of control which are related to privacy
as: "control over choice", "control over access" and "control over stimulation". It means that for a person to have privacy, he or she should have the freedom of being private or not, then he needs to control the interruption and observation of activities, thoughts and informations, and should be able to direct and choose the type and intensity of stimulation desired.

Generally in an office two kinds of privacy are required: acoustic and visual privacy. Visual controls prevent occupants of the workstation of being seen, minimize physical interactions, and interruptions. Acoustical controls lessen unwanted and distracting machine or conversational sounds to and/or from the workstation and contribute to confidential conversations.

Privacy is usually seen as a problem in open-plan offices. Hedge (1986) reports that:

typical among the problems (of workers in open plan offices) are complaints of loss of privacy (both visually and conversationally), high incidence of both visual and aural distractions, frequent interruptions by other employees, and problems with the ambient conditions (p.140).

However, the users of this kind of planning claim that privacy which is provided in conventional offices generates an excess of isolation and prevents strong relationship with other members of organization. To face
this problem open planning eliminates this kind of total isolation, but still offers a variety of levels of limited privacy gained by reasonable placement of screen barriers, wardrobes, plants and similar obstructions. Pile (1978) speaks about the usefulness of being able to see other people and activities in progress within one's area of concern as long as the view is not distracting. He claims that this reduces many wasteful walks from place to place, telephone calls, and so on. He says that there is no valid reason why an office worker should feel it necessary to be hidden at normal work. According to him acoustic privacy, is something tied to the general acoustical climate of the office space.

It should not be forgotten that privacy is a form of interaction which involves not aloneness or separateness, but rather the need to control information about oneself in the process of interaction with others (Laufer, et.al., 1973). For individuals to function effectively, over time, a reasonable balance between interaction and privacy should be achieved. Sometimes the physical setting may tend to create conditions to get privacy or may tend to reduce it because it leads to isolation. Also privacy has a very close relation with the status. As the rank of the worker raises, his/her degree of privacy increases. Different levels of control over access and privacy is available for the people with different ranks. For example
to meet a manager, one should take an appointment or should take a permission from his secretary, whereas everybody may enter to the room of a clerk without any permission.

Actually privacy is a matter of degree, the need for privacy changes from person to person and from one job to another. Goodrich (1986) states that perceived privacy is sometimes more important than privacy itself. He gives examples of studies that suggest people feel more private when there is a large group of workers in the same area, than when working with a small group of people (2 or 3) in the same place. It may be because of the anonymity of the space. He also claims that the required privacy differs with job. Jobs demanding creative thinking get more distracted by environmental distractions whereas with routine, repetitive and mechanical jobs, too much privacy isolates an individual from his or her co-workers and increases reports of job stress, errors, perceived fatigue and boredom and reductions in attention and group morale. There are some kinds of jobs that do not need any privacy. Davidson (1990) in a research about traders’ desks states that traders need to see and hear everything around them and find that privacy gets in the way of their productivity. On the other hand Goodrich (1986) also reports that desired level of privacy changes with the age and sex of the workers. Older and female employees desire more privacy than do younger ones and males.
The required degree of privacy also changes with the technology used in the office. Goodrich (1986) describes it as:

Office technology changes the way a person works. Interacting with a video display terminal (VDT) is very absorbing and focuses the user's attention. The user requires less privacy, is less distracted by nearby activities and needs greater environmental variety compared with a person who is using paper and pencil technology (p.116).

In fact one of the impacts of the office automation is worker social isolation. In non-automated offices workers move around to do different jobs like storing and retrieving documents, etc.. While doing this, workers have some contacts with other people. In contrast to that, workers in automated offices may do filing and retrieval of documents from where they are and there is no need to move around. So, the computer terminal becomes the primary focus of interaction. People no longer work with each other but they work with video display terminals. This may lead to social isolation of the workers. If the privacy barriers in the office are planned in a way that they separate each worker from the others, it can also encourage isolation. Therefore, in privacy planning in an automated office this factor should be considered carefully and the arrangement of the workstations should permit and encourage some interaction between the people.
Considering all mentioned factors, privacy planning becomes a very important part of an office planner's job. Typical components that contribute to visual and acoustical control in the open office are: walls, panels, file banks, storage cabinets, and planting. By different placement of these components various levels of privacy can be achieved:

Full enclosure can be achieved by using ceiling to floor partitions whereas semi-enclosure can be provided by either using half-height partitions and workstation layout or file banks and planting.

Direct eye-to-eye sight lines can be avoided by careful planning of the workstations. It is usually possible to arrange workstations in a way that the straight-ahead view in normal working position does not include other people. Also, no one should see the active lines of circulation from a normal work position. As far as privacy is concerned, many of possible configurations of partitions may be interchangeable. Low partitions, over which people can look when standing, may provide little privacy, however they may be used for defining boundaries of workspaces and for supporting office equipment. Generally to provide an appropriate level of privacy in most of the workplaces, it is useful to enclose them at least by three partitions. When using partitions the desired level of
privacy should be carefully decided and the arrangement of the panels should be in a way that spatial clarity is not missed and the space is not visually boring.

Erdemir (1979) states that privacy is an important factor in the social life of Turkish people and that compared to the people of the western countries working in the open offices, in Turkey privacy factor becomes more important for the workers in this kind of planning.

A concept very close to privacy is territoriality. It is actually a way of having and expressing self-identity in the workplaces. Workers tend to treat their workspaces as physical territories, that is the zones of control. It is the zone that the influence of the individual is recognized and the occupant can regulate contact with others within that. It permits the occupant to maintain the appropriate psychological distance -not too close and not too far- which is necessary for a healthy interpersonal relationship. In conventional offices the walls of the rooms used to show the limits of a worker's territory. Since in the open offices there is no room, panels often are used for this purpose. In addition in most of the open-plan offices, personalization of the space demonstrates to co-workers and others that the workspace is, in fact that person's zone of control. So, personalization can be counted as a central component of territoriality in the workplace.
6.3.3. Self-Identity and Personalization

While the workstation should satisfy the functional requirements of the task, it should also allow for self-expression and personal comfort. An individually assigned workstation (personal space) represents a symbolic medium for the worker's self-identity. Sundstrom (1986-a) defines self-identity as:

Self-identity means an individual's own vision of his or her lasting characteristics and habits, particularly those that differentiate that person from other people (p. 217).

A major way of expressing self-identity in an workplace is the personalization of the space.

The term personalization describes the display of personal items or arrangement of workspace to distinguish the occupant from the others. Sundstrom (1986-a) reports that:

Personalization of workplaces may contribute to employee's satisfaction in part because personalization may lead people to feel that their individuality is recognized. Limited evidence suggests that office workers regard personalization as important, and that they are relatively satisfied in workspaces that have room to display personal and work-related items (p. 224).

So, the designers of furniture systems should provide the
means of personalization of space by providing display spaces for each worker such as display screens and shelves for personal belongings and by using furnishings that can be added, changed, and refurnished easily by the user. Of course to achieve this mean, the mechanical details of screens and other components of the system should be simple enough to be manipulated by the user without any help of "experts". The concept of personalization is also very closely related to status. As the status of a worker changes, the level of personalization allowed in the workstation changes too. As it was mentioned in the previous sections, in most of the offices the level of personalisation allowed within a workstation is a status marker. The most effective type of personalization of the space can be achieved through participation in its design. In this method designers consult with the workers of an office about the configuration of the workplace and the type of furniture to be selected. This method is described in detail in the other parts of the thesis.

6.4. The Role of The Culture

The way a person sees the world and experiences a space is molded and patterned by his culture. Hall (1969) describes this fact as:

No matter how hard man tries, it is
impossible for him to diverse himself of his own culture, for it has penetrated to the roots of his nervous system and determines how he perceives the world. Most of culture lies hidden and is outside voluntary control (p.188).

In this light it can be said that the perception of all factors discussed in the previous parts is also directly related to the culture. Even the distances mentioned in the inter-relation section are not universal. "What is intimate in a culture may be personal or even public in the other" (Hall, 1969, p.128). The perception of privacy, status and even territory is not also the same in different cultures. Something which is a status marker in a society may not serve the same function in the other. So, when a design concept, such as systems furniture are borrowed from another culture, it should be adapted to the social realities of the user country.

Therefore, if the goal of the design is not only to serve functions which are going to be done in a space but also the psychological and social needs of the user, it seems that there is a serious need of some analyses of the social facts in Turkey and behavioral patterns which influences not only the design of the offices but also the design of houses and other spaces as well.
The problem of distributing the power in the office is one which has existed since the first examples of open-plan offices were designed. The problem has not lost its importance at all today as well. By technological transition from the mechanical to the electronic and by appearance of automated offices, more electronic equipments began to be used in the office. Each individual workstation now includes a vast range of electronic peripherals (phones, mini or personal computers, printers, facsimile machines, etc.), and for the first time individual environmental control systems are also included in the furniture systems.

More equipments means more power, communication and signal requirements. This means an ever-expanding inventory of wires, cables and cords, which increases the problems of wire management, flexibility, accessibility and aesthetics. Knobel (1987) describes this problem as:

Unlike most previous office technologies, the computer produced particular problems; a proliferation of wires and heat, and a need to carefully control light and static. For furniture designers, the wire proved the principle problem. There could easily be a need for a 'clean' power supply (not contaminated by electrical interference) and
connections to a printer, to a separate disc drive and to a data network. And of course, the existing wires on a desk-telephone and light- were still necessary. Without some means of controlling the wires, fire hazards, maintaining data connections, and just unsightly mess in the office resulted. So from concentrating on paper storage, office furniture designers turned their attention to 'wire management' (p. 89).

7.1. Wire Management

An automated workstation should handle all the power, communication and signal requirements. That means, all wiring elements should be controlled and distributed in an organized, safe and visually acceptable manner.

Power is supplied to the building through the ceiling, walls, or floor. If the power is brought to the work areas through the ceiling, the wiring may be contained in vertical service poles. Outlet boxes which sit on the carpet are conventionally used if the wiring is brought through the floor. A more viable solution for floor power and signal is outlet boxes which flush with the carpet. These are installed in a grid pattern which permits service to any work-place arrangement. The power should be carried from these points to the different equipments in the workstations without leaving dangling and floor-cluttering wires and cables which may produce both safety hazards and a visually disturbing view. To conceal the wires and to carry the power from source to equipments,
different methods are used by office furniture manufacturers. These include:

- Creating small openings on the work surface so that wires can drop beneath this surface. Wires often dangle loosely. This method may be used in the first and fourth types of the systems and conceals the wires on the desk top but the wires and cables on the ground remain which may be visually unpleasant and may create safety hazards. On the other hand comparing to the other methods, changes in the wiring is much easier with this one (Figure 7.1).

![Opening on the worksurface](image)

- Using hollow furniture components, such as worktable legs and panels to conduct the wires. This method can be used with all types of systems. This method prevents cables of dangling and is easy to be used. The important thing to be noticed is the connection of the cables which come out of the panel or table with the power source. If the power source is not near enough, the wires on the ground may
create some safety problems. Maintenance requirements can be met easily. The connection holes on the surface of the desk and the provided pathway in the legs, panels and other components should be big enough to accommodate wires of the different equipments used in the workstation (Figure 7.2).

![Figure 7.2](image)

Using hollow furniture

- Securing channels or tubes to the underside of the work surface through which wires are threaded to the power source. These channels can be clipped on where most frequent wiring changes are necessary. Changing and repairing the wires are relatively simple. Pulgram and Stonis (1984) say that:

> These fittings distribute cords, wires and cables throughout the workstation to the convenience outlets. This wire management system can greatly improve the aesthetics of a workstation by concealing unsightly wiring while ensuring the safety of its occupant (p. 71).
- Using a spine under the table to thread the wires and cables through it. This method is specially used in some of the systems in which table is the basic unit. Instead of hiding the wire management devices, some designers prefer to exaggerate them. Usually this spine can be easily opened whenever a change is necessary. Some tables which use this method have "power ends", that is a thick base which fits over a floor monument, and which accommodates receptacles, phone jack, data ports and switching (Frieman, 1990).

- Providing baseboard raceways in system furniture support panels. Data and communication cables and telephone and electrical wires are routed horizontally through these baseboard assemblies. Post connectors positioned between workstation panels allow wiring for task/ambient lights to thread vertically from power points located in the baseboard. This method is used with systems which are based on supportive panels and is mostly recommended since provides the workstation with ready outlets for both communication and power delivery. The existent outlets in the panel provide power and communication delivery for all the equipments. It should be noted that by installation of all wiring required to accommodate the various electronic needs of a workstation within the partitions which can be plugged into or out of the building's distribution system, reconfiguration of
the building becomes much more practical and fast. Figure 7.3 shows an example of this system of wire management.

![Figure 7.3](image)

Figure 7.3
Raceways within the panels
(Source: Abak system, B & B Design)

In all mentioned methods power and communication cables should be contained in separate raceways as these are quite different both in function and in design. Figure 7.4 demonstrates two alternatives for wire and cable management, when the power delivery is from the floor and when the power is taken from the ceiling using a power pole.

While designing an automated workstation, designer should know the wiring specifications and cable requirements of various equipments used in that workstation since these
Power delivery from the ceiling

Power delivery from the floor

Figure 7.4

Two alternatives for cable and wire management

(source: Steelcase, 2000 furniture system series)
differ between various equipment manufacturers. Moreover, power cords, communication connections and cable requirements for each piece of equipment should be determined. Then the most appropriate distribution system for routing wires and cables through the partitions and/or furniture, between the building's power distribution system and the equipment can be decided. Pulgram and Stonis (1984) mention that:

Typically, workstations have low amperage requirements, but they do need from four to six outlets, depending on the tasks and equipment. Provision of two to three separate circuit is desirable (For Turkey 220 v/ 10 amp circuits)(p. 69).

These electrical circuits are necessary for making outlets, lighting, and special-use equipment accessible and convenient. Telephone lines and data cable requirements must also be accommodated within the workstation. Adequate number of outlets in the workstation for plugging in electrical equipment and adequate cables for telecommunication equipments should be provided. existence of a cable storage space in each workstation makes easy changes in the location of the equipments possible. The aim in design of a wire management system should be to provide maximum flexibility in terms of wiring and cabling that can be adapted to different and changing demands of an automated office.
7.2. Utilities for Personal Control of Environmental Factors

Today there is a tendency to make the control of heating, ventilation and air conditioning (HVAC), lighting, and background sound more personalized to afford greater comfort and privacy to the workers in automated offices. Therefore, independent controls are being developed in conjunction with distributed HVAC. Loftness, et.al. (1990) state that:

there has been a shift towards multiple-zone HVAC systems and a move away from four to five zones-per-floor controls to local fan coil units and dual duct systems or at least multiple variable air volume controls that offer better management of air temperature (p.48).

To obtain the highest level of personal control over air conditions in workstations fresh air can be ducted to each desk, and dimmer controls for cool air as well as heat, task light and even white noise can be provided. In the automated office where some of the equipments tend to create "hot spots" individual temperature controls may have a big role in creating a comfortable environment. Wierenga (1985) reports that:

A visual display terminal (VDT) gives off more than three times as much heat as a
standard electric type writer, and many VDTs in continual use can significantly raise the temperature of a workspace (p.30).

Thus, the ventilation system have to be adjustable to direct the flow of air to these areas as needed. The workstation then, may contain a control panel and necessary circuits for these dimmers and controls. When so, the designer should know the requirements of these devices and should add adequate space and wiring to the system. In addition, when necessary, ducts to conduct the air in to the workstation should also be planned.
Furniture systems may:

- Use free-standing vertical screens and conventional type office furniture,
- Use panel-supported components,
- Use storage-wall massive cabinet units,
- Be table-based.

Furniture systems usually contain:

- Work surfaces
  Desk, VDT table, printer table, conference table (free standing or panel-supported)

- Storage and filing components
  File cart, group file, devices to store computer-based or micrographic-based filing media, book case, wardrobe, drawer units, shelf-storage units (free-standing, panel or table-based)

- Lighting components
  Task and/or ambient lighting (free standing, integrated in to the workstation or attached to the work surfaces or panels)

- Accessories
  Visual aids boards, visual/acoustical screens)
Organizational Needs

To decide about the type of the system to be used and the arrangement of the workstations and to determine the necessary components in each workstation and the configuration of them, analyzes of the work flow, tasks done, communication methods, filing system, equipments used and facilities required within the organization should be made. These analyses give informations about the relationships of the workers in the organization with each other and with the customers, the equipments and facilities.

General Criteria in Design or Choice of Furniture Systems for the Automated office

Functional requirements:
- Accommodation of all necessary equipments and reference materials,
- Stability in material and construction,
- Ease of movement between the work surfaces,... for the user,
- Ease of movement on the carpet for chairs and file carts.
Health/safety requirements:
- Fire-proof materials for files, ...
- Concealing of the wires,
- Roundness of the edges of the items,
- Long, thin and narrow feet for the panels,
- Electro-static materials for carpet and upholstery fabrics,
- Natural materials for furnishing items when possible,
- Materials used should not produce toxic fumes.

Maintenance requirements:
- Easily cleaning materials and adequate floor clearance,
- Easy access to wires and cables,
- Durable materials against stain, heat and scratch.

Environmental requirements:
- Acoustical treatment of the panels and other items (suitable materials for acoustic screens and upholstery),
- Non-reflecting, matte finishing and unsaturated colors for the large objects.

Aesthetic requirements:
- Variety in finishings, colors and textures,
- Distribution of colors and forms to create visual balance,
- Variety in panel heights.
Ergonomic Considerations

Postural considerations:

Work surface heights:
- For manual tasks: max.: 76.7 cm, mean: 74 cm,
- Keyboard height: 70-85 cm (adjustment range),
- For peripheral equipments (to be used when seated): 71-76 cm.

Legroom dimensions:
- Width: 68 cm,
- Height: 68 cm (clearance between the seat surface and the lower edge of the table: 17-20 cm),
- Depth: 60 cm (at the level of the knees) and 80 cm (at the level of the feet).

Screen:
- Height: 90-115 cm,
- Inclination: 88 -105°,
- Distance to table edge: 50-75 cm.

Shelves heights:
- Over-table: 135-147 cm (distance between the lower edge of the shelf and the surface of the table: 38 cm),
- For using from a standing position: max. 175.5 cm.

File-drawers' height:
- Used in standing position: 137-147 cm,
- Used in sitting position: 71-76 cm.
High counter's height: 86.5-99 cm.

Work surfaces' width: 114-183 cm.

Work surfaces' depth: 76 cm.

Keyboard (middle row) to table edge: 10-26 cm.

Distance between the file cabinet and the table (used in a sitting position): 122-173 cm.

File drawer extension zone: 45.5-66 cm.

Some remarks:
- Use adjustable work surfaces (especially for keyboard and screen) and shelves,
- Provide enough space for non-VDT functions in the workstation,
- Provide easy handling of the adjustment controls,
- For high-counters use adjustable high chairs with foot-rests.

Chair:

- Dimensions:
  - Back-rest height: 48-52 cm,
  - Lumbar pad to seat surface: 10-20 cm,
  - Back-rest width: 32-36 cm,
  - Back-rest horizontal curvature's radius: 45 cm at lumbar pad and 65 cm at the shoulder height,
  - Seat width: 40-45 cm,
  - Seat height: 38-54 cm,
  - Tilt of the seat: 4-7°.
- Arm-rest height (from the seat surface): 22.4 cm.

-Cushioning and upholstery:
  - Should allow air circulation over the skin surface,
  - Should have some humidity absorbing capacity,
  - Should have adequate thermal diffusivity properties,
  - Should have texture to provide a suitable friction,
  - Should not restrict the movements of the user.

- Other remarks:
  - Use tilt mechanism to adjust the angle of the seat,
  - Use swivel mechanism to allow lateral movement,
  - Use pneumatic devices to allow easy height adjustments,
  - Use castors to provide ease of movement,
  - Use adjustable arm-rest to be used when desired,
  - Use suitable countering to distribute the weight evenly and to provide enough support for the body,
Design the front edge of the chair with a curve,

Use inclination adjustment devices that can be locked at any desired inclined for the back-rest.

Complementary devices:
- Foot-rest,
- Palm-rest,
- Document-holder.

Visual considerations:
- To avoid glare:
  - Use matte finishings and unsaturated colors with equal brightness for the large objects,
  - Place workstations in a way that light fixtures be parallel to and on either sides of the operator-screen axis,
  - Use task lighting.

- Viewing distance (distance between the eyes and the screen): 50-76 cm.

- Viewing angle (the angle at which the screen should be placed): 5° above and 30° below the horizontal line.
Social and Psychological Considerations

At organizational level:

- Suitability with the image that the organization wants to impose on its clients and workers,
- Suitability with the status of the users and their roles in the organization (using different materials, sizes and styles for furnishings, level of enclosure, floor space,... different workstations for different ranks can be designed).

In inter-personal relationships:

- Provision of a sufficient distance between each worker and the other people to assure a healthy social relationship.

At individual level:

- Creation of a spacious interior by not using too many items within one workstation,
- Sufficient degree of visual and acoustic privacy:
  - Reasonable balance between interaction and privacy (required degree of privacy changes with the organization's work flow, job's characteristics, age and sex of the worker, technology used,...):
    - Prevent social isolation of the workers by encouraging some interaction between the people,
    - Create different levels of enclosure
for people with different needs, using full-height and half-height panels, plants, file banks,...,

-Avoidance of direct eye-to-eye sight lines.
-Allow workers to define their territory using panels or some means of personalization.
-Provide some display spaces such as display screens and shelves for personal belongings to allow workers to express themselves through personalization of the space, or design the workstations in a way that can be easily added, changed and refurnished by the user (use simple mechanical details).

Technical Considerations

Wire management:

-Different ways of carrying the power from the source to equipment:

-Creating small openings on the surface of the work surface,
-Using hollow furniture components,
-Securing channels or tubes to the underside of the work surfaces,
-Using a spine under the table to thread the wires and cables through it,
-Providing baseboard raceways in the support
panels.

- Accommodate power and communication cables in separate raceways.
- Investigate the wiring specifications and cable requirements of different equipments used.
- Provide adequate number of outlets in the workstation.

Utilities for the personal control of the environmental factors:

- Provide necessary circuits for dimmers and other controls.
- Provide ducts to conduct the air into the workstation when necessary.
9. CONCLUSION

As mentioned in the previous chapters, several factors should be considered in the design of the automated office furniture systems. Some of these are related to the requirements of the new technology used, some related to the work flow within the organization and the other to the needs of the workers. From these three groups, it seems that the last one is often overlooked in the office furniture design. Most of the times, the workers' needs come after the requirements of the organization and the tools. Even if in some cases the ergonomic requirements of the workers are answered in the design of the furniture, the psychological and social needs are often not considered. As a result, usually offices are not very pleasant places to work in. Now the aim of the designers of the automated office, and automated office furniture, should be to create better places to work and "to live", places which can help in reducing the mental and physical loads placed upon the workers by the demands of the new technology. This is only possible by a concentration on solving the problems of the workers, taking in mind that they are all individuals with different personalities and different needs.

Therefore, the systems furniture should be as flexible as
possible to answer these needs. The parts of the system should be adjustable so that any worker can assume the most comfortable working posture for her/himself. Moreover, different items of furniture should be interchangeable and easy to be reinstalled by the worker to permit him or her to rearrange it according to his/her will. Preferably the system may contain some free-standing items that can be easily changed or replaced by the users.

On the other hand when arranging the workstations social and cultural norms of the society that it is going to be used in, should be analyzed carefully. In case of furniture system which is a concept borrowed from other societies with different cultures and social structures this is extremely important, since this concept is developed not only to serve functional purposes but also to have an impact on the behaviors of the users.

In summary the aim should be to "humanize" the automated office and to create a better work environment which contributes to the people's satisfaction and efficiency. All aspects of furniture design, from organizational and technical considerations to the ergonomic, social and psychological considerations should be approached in this light to create environments which allow more comfortable working conditions, and better social interaction between the people in the automated office.
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