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GUIDELINE FOR WORK STATION DESIGN

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Preface

The computerized work station is considered the key to increased office productivity by most organizations. While technology supporting the office worker receives considerable attention and resources from management, work station furnishings and layout are not given comparable treatment. Instead, work station space and furniture decisions too often reflect a rather unsystematic approach to determining requirements to perform necessary office activities. Space allocations and furnishings are frequently dominated by status issues and tradition. Yet, if productivity gains are to be achieved, work station design must be responsive to the needs of the individual worker.

Effective work station design has three major objectives:

1. Facilitate the performance of necessary activities
2. Minimize the problems associated with office work, e.g. noise, glare, distraction, thermal discomfort
3. Provide sufficient space for the person and the materials need to work effectively

Traditional design approaches have been "top-down" and divided into architectural/engineering and interior design issues. In this scheme, the requirements of office workers were dealt with after most environmental, technological, space allocation and furnishings decisions were made. The individual work setting features were largely dictated by the constraints imposed by decisions already made. Under these circumstances, it is not surprising that surveys of office workers repeatedly demonstrated a severe mismatch between the needs of workers and the environments provided at their work stations. These problems were greatly intensified with the addition of technology - the automated office.

If the promise of the automated office is to be realized, the office work station must be responsive to the needs of individuals performing particular activities. However, since there are so many different activities performed in offices and they change rapidly as a result of technological and organizational factors, it is neither feasible nor sensible to develop specific work station designs tailored for each of them.

While office activities, furnishings, and technologies, constitute "moving targets", there is an alternative approach to determining work station needs - one unaffected by these changes.
It is an office design <u>process</u> that differs from the traditional one. The process starts with identifying the activities performed by office personnel and evolves into work station dimensions and configurations that support the work performed. This approach is hardly a new one; it has been used for years in buildings such as hospitals, manufacturing plants and other special purpose facilities.

The report is organized into four parts:

Part 1. Background - Identifies current problems in automated offices and describes the needs of office workers for optimizing job performance and satisfaction.

Part 2. Recommended design process - Describes a procedure for designing automated office work stations, starting with a definition of activities and culminating with sample layouts.

Part 3. Work station issues - Discusses the work station as the central focus of office design.

Part 4. Design context issues - Describes the interaction of work station design and other building and design features, e.g. lighting, acoustics, wiring, furnishings.

The present report is the latest in a series of documents prepared for the Public Building Service of the General Services Administration. It touches upon issues in Part 4 that are dealt with more extensively in the following previous reports:

a. Rubin, A. "The Automated Office - An Environment for Productive Work, or an Information Factory", NBSIR 83-2784-1, National Bureau of Standards, Gaithersburg, Md, Nov 1983.
b. Rubin, A. "Revised Interim Guidelines for Automated Offices", NBSIR 86-8430, National Bureau of Standards, Gaithersburg, Md, Aug 1986.

Part 1 Background

Chapter 1 Introduction

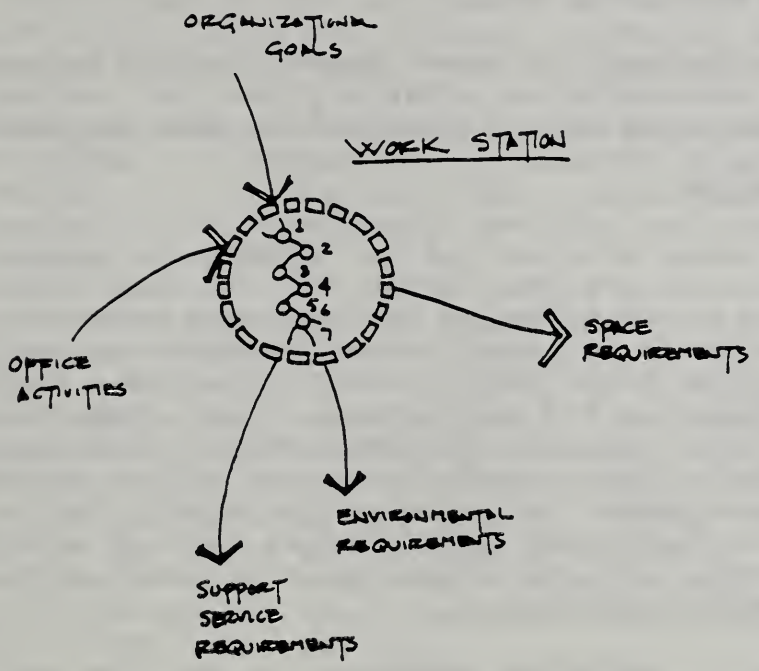
Since the advent of office automation, the number of clerical workers has decreased, while the number of knowledge workers in offices has increased substantially. The change in the makeup of the office population from clerical to knowledge workers has intensified the demand for high quality office environments, relief from video based work, and a "voice" in making decisions about work station design. Knowledge workers have more education, greater expectations, and a willingness to change jobs for intangible benefits such as better surrounds, than their clerical counterparts. The amenities provided by appropriate design can be a deciding factor in determining whether to change jobs (1).

The computerized work station with a VDT and a multi-featured telephone system with a modem is rapidly displacing the traditional desk. It is the basic "building block" of the office today, designed to improve organizational effectiveness by increasing white collar productivity, which has been virtually stagnant for many years (2). Research findings obtained during the past several years have indicated that increased office productivity depends on the "unleashing" of these knowledge workers, i.e. providing the environments and office tools needed to use their skills, knowledge and decision-making abilities (3).

The federal and private sectors have extensively employed such work stations. Yet, those faced with design decisions find little information available to assist in making intelligent choices concerning work station design. This is the case despite the fact that many organizations have been acquiring and employing new office technologies since the early 1980's. Few guidelines and standards deal with work stations. Perhaps, equally important, and also lacking, is an approach that facilitates the collection of needed information to define work station requirements.

The present document provides a rationale for work station design, based on office activities. It describes a procedure for determining work station space requirements and furniture configurations, consistent with organizational goals such as space reduction and improved productivity, while enhancing job performance and worker satisfaction.

Figure 1.1 Work station design procedure



The report draws upon an extensive literature search, review of design practices, and interviews with architects, facility managers, and end-using organizations. It also presents a synthesis of "lessons learned", primarily from systems furniture use, to capitalize on federal and private sector experiences in developing cost-effective design solutions. These recommendations consist of a combination of design approaches and features which support worker performance, and are likely to overcome problems found in high technology offices.

In formulating work station requirements, space considerations play a vital role. A prerequisite for effective work is the necessary space to accommodate the individual, the activities performed, and the furnishings and tools needed to function effectively. Significant concerns include space adequacy in terms of capacity, configuration and location; sufficient and appropriate electrical power, and cooling to offset equipment heat load.

While the report focuses on the work station, it also deals with office design issues which importantly impact the effectiveness of the individual worker (4). The work station is not a stand-alone entity, but must be considered in the context of its surrounds. For example, decisions about work station components require choices as to whether activities such as meetings with individuals are to be performed in

jointly used spaces (small conference areas) or at individual work stations.

Since this document is based upon limited findings, it should be considered an interim guideline, anticipating periodic updating as our information base expands.

1.1 Background

Effective space utilization is required to ensure that federal dollars are well spent. Of critical importance in this regard is sensitivity to long term building costs since the expenditures for staff salaries often exceed 90% of total building costs during their lifetimes. Savings on building features and furnishings which compromise the work performed does not make economic sense. Furthermore, when considering building performance and worker productivity, facility management and maintenance should not be neglected. They play an important and integral role in organizational effectiveness, yet are often neglected during the design decision making process.

Traditionally, building construction and the outfitting of interior spaces have been treated separately. This approach should be altered if organizations are to make the best use of technologies and office spaces while optimizing worker performance. The effectiveness of the office, furnishings and technology depends on their responsiveness to the needs and desires of occupants and managers of office buildings. Today's systems reach the level of individual work stations and telephones, traditionally considered to be furnishings provided by the occupant. The design process should reflect this system perspective (5).

Unfortunately insufficient and/or improper planning has characterized the introduction of office automation. At a time when the work environment has increased in importance it has frequently deteriorated. Machines producing noise and heat placed on desks designed to support paper-based activities is a frequent cause. Office automation has been largely hardware-driven; machines and systems have been purchased and installed to increase office productivity with insufficient design planning.

New technologies have also resulted in new problems for office workers. With the introduction of electronic based information systems, a person at a work station often communicates only with a VDT-based terminal during an eight hour work day. Little need exists in many activities to work personally with office colleagues. Office workers have complained about a sense of isolation, and their subservience to technology. Questionnaire surveys have also identified a desire for visual and auditory privacy, glare-free lighting, and control of the immediate

environment as important design issues for knowledge workers (4). Office design can be used to alleviate these problems by providing places for informal conversations and a general appearance which provides visual relief from technology.

It is at the work station that information and communication technologies are merged into a powerful system managed by the worker. Initially confined to secretarial and data processing tasks, electronic devices are increasingly used for managerial work.

The work station should be designed to meet a variety of requirements differing from person to person - physical, sensory, and cognitive. Flexibility is essential for work station furnishings and equipment. For example, selecting and placing objects serving the worker requires considerations of physical comfort, body movement, and individual preferences and needs. Employees need ready access to the tools and materials needed to do their jobs. Appropriately sized components, clearances, allowances for free body movement, are integral to the proper fit of a person to the work station.

Work station design should enable individual expression and personalization to offset the stark environment associated with automated workplaces. It should reflect the user's working style and permit some autonomy such as rearranging furnishings or positioning task lights. Work surfaces need to be larger, especially during the transition from a traditional work setting to electronic ones. They also must support paper and computer-based work.

Work station design should also accommodate the ergonomic needs of the worker, avoiding backache, eye fatigue, tired wrists and neck strain - often accompanying prolonged VDT work. Configurations of spaces, furnishings and work objects must facilitate work, not impede it.

Finally, physical and visual diversity and relief is needed for VDT workers. Lounges and other settings for informal contacts; coffee/break areas, small conference rooms.

Chapter 2. The work station and the design process

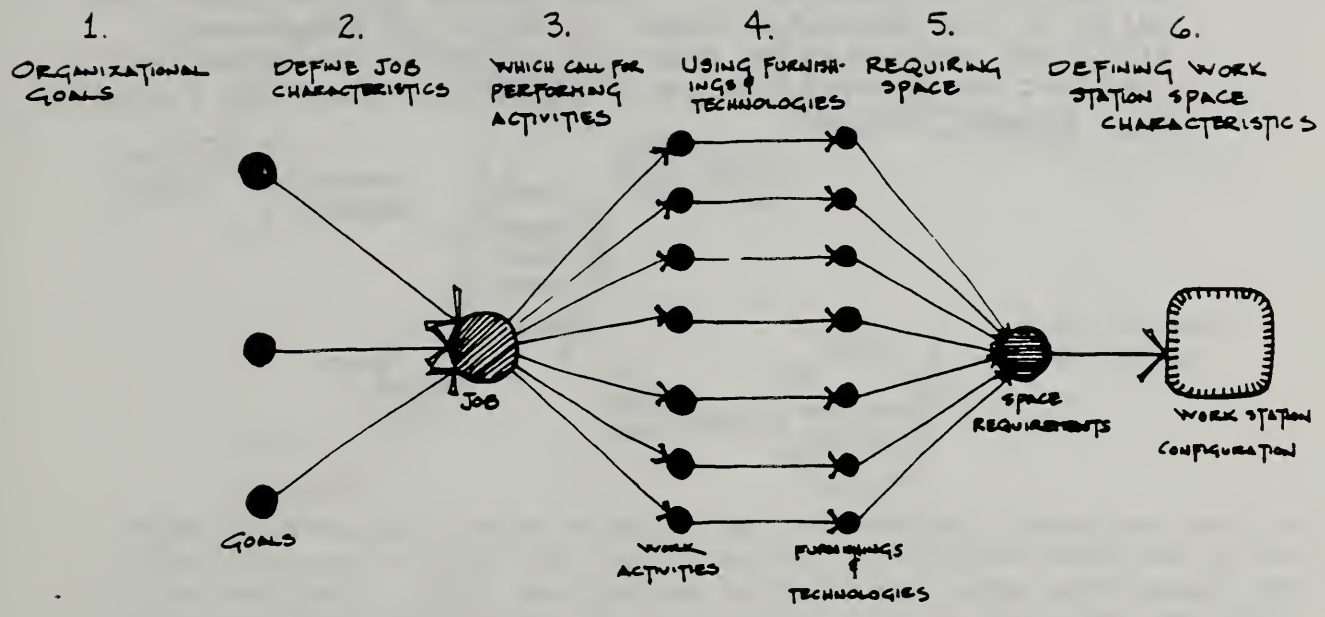
"Programming is an on-going process that determines the functional and technical performance requirements of a facility to improve the quality and efficiency of buildings. Current programming and related planning activities vary from organization to organization, but its purpose is consistent: to help building users explore options for meeting their facility requirements" (6). The design program therefore constitutes the conceptual framework used by the designer in meeting the building needs of a using organization.

One method of approaching office design is to employ a dual strategy in developing a design program. First, the general goals of the user institution, its organizational structure and functions are considered. This "macro" description is accompanied by a detailed analysis of office activities and an identification of the tools and furnishings needed to accomplish needed work. This approach is sometimes termed 'inside-out' space planning, and forms the basis for this report (3).

The design process is influenced by the focus on the individual work station. It is important to anticipate what electronic and communication systems are likely to be used, and how. This procedure entails analyzing office activities to a degree not normally practiced and to do so in a timely manner. The single most important requirement in designing high technology offices is to ask the right questions and seek the proper expertise, early in the planning and design stages. It is at these stages where the office activity analysis plays a critical role, and where the work of a professional planning team becomes invaluable. This detailed analysis can avoid the later discovery that a particular option was not considered, or became unduly expensive by an earlier decision made without full realizing its implications.

For example, if adequate provision for the necessary physical hardware is not part of the design, many promising technological options for communication, information systems and building control will either be rejected or be more expensive to introduce later. Figure 2.1 illustrates a space planning process.

Figure 2.1 A space planning process



Another requirement is to determine the flexibility needed to respond to technological advances and organizational changes. Decisions can then be made concerning occupant requirements that define the basic building systems; e.g. power, environmental control, communications.

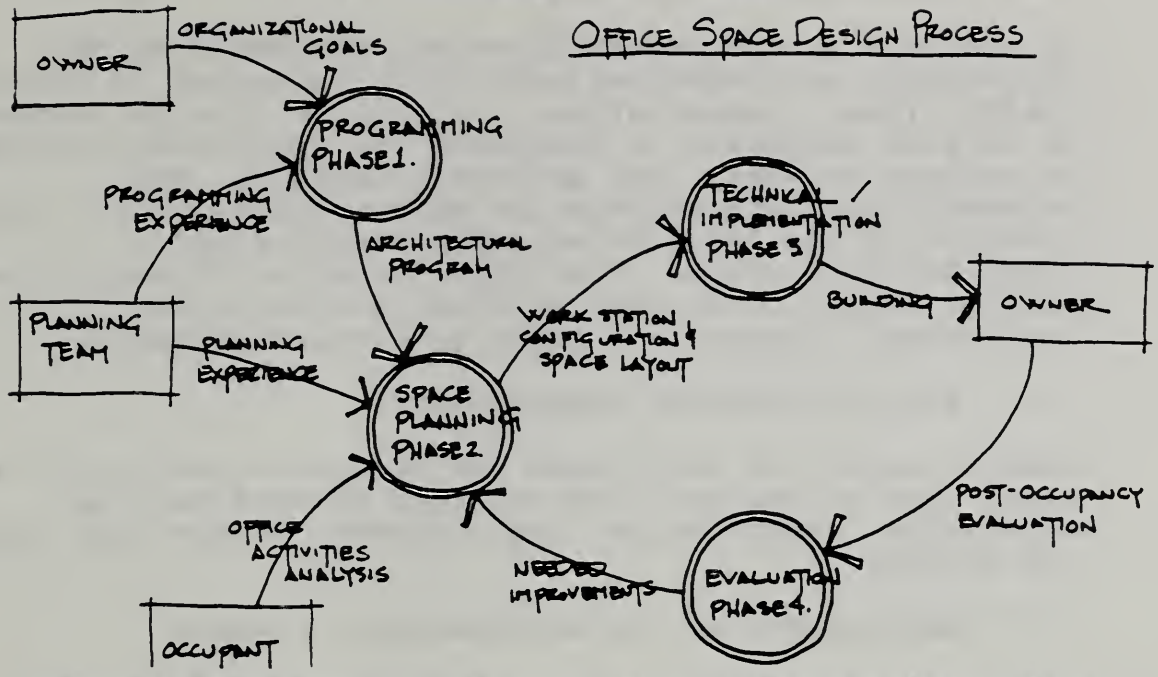
An additional factor with far reaching design implications concerns the degree of autonomy given to the individual with respect to design and work performance. Are end-users to control environmental features such as lighting and temperature? Which office devices are to be at the work station, which in shared spaces? What access is required for telecommunication and information devices? These issues should be resolved before major decisions are made concerning wiring distribution, HVAC and lighting systems.

2.1 Planning

Designers and office automation experts are in general agreement that detailed planning is an essential prerequisite for automating office activities.

The program should be a collaborative effort between the owner and a professional planning team (figure 2.2). A planning team should include organizational representatives from human resources, technology, information management, facility management, electronics, telecommunications, office automation and design (3). They should all be consulted early in the design process. By enabling people with different expertise to make their viewpoints known early, ineffective designs can be averted and tradeoffs evaluated in a timely fashion.

Figure 2.2 Office Space Design Process



When determining work station environmental features such as lighting and acoustics, surrounding conditions must be taken into account. Light and noise reflections are influenced not only on the properties of materials within the work station but on those in nearby areas. Similarly, the space needs for individual activities are dependent on the proximity and availability of jointly used facilities such as duplicating, printing and conference areas (7).

The end-using organization, including building occupants, play an especially critical role in defining activities, and the technologies needed. This activity analysis and the architectural program, provide initial data for space planning. The last design process phase should include a feedback system for evaluations of operational and building activities during building's lifetime.

2.2 Planning Approaches - Programming

The information developed during the planning phase will serve as the basis of the design program.

2.2.1 Objectives and Philosophy.

A clear statement of organizational goals is the first step. These are based on the history and background of the organization and its attitudes and expectations towards its clients and staff.

2.2.2 Functional Relationships.

An analysis of the interactions and transactions of individuals and organizational units is needed to understand traffic flow, communication, information flow and access. It is also necessary to determine the appropriate placement of support services such as word processing, mail reproduction, data storage and communication, etc., with relation to the location of administrative and organizational units. The proper location of conference and meeting rooms, libraries, internal waiting areas, lunchrooms, lounges, all merit particular attention.

2.2.3 Facility Spatial Requirements.

Spatial needs for individual and organizational units are based upon a complex of interacting factors such as ergonomics, communication requirements, status, and needs for privacy.

2.2.4 Development of the Architectural Program

The program should be written in performance language, describing the functional requirements of a system for example, not its hardware specifications. It should reflect the common understanding of the owner/user and the planning team.

2.3 Recommended steps in the office design process are (8):

1. Identify office objectives.
2. Determine the specific functions critical to accomplish objectives.
3. Define the space and equipment requirements for each office function.
4. Define the interrelationships among office functions with the help of the staff.
5. Determine the office facility location.
6. Generate alternative space plans.
7. Evaluate alternative plans by identifying critical criteria and weighting them accordingly.
8. Implement the plan chosen.
9. Maintain and adapt the plan as changes require; employee involvement is critical to identify equipment needs and provide feedback information, using a POE.

Part 2 Recommended Design Process

Chapter 3 Design approach

The work station design process advocated here starts with the definition of organizational goals and office activities. Work station space requirements, support services, and environmental requirements are then determined by a detailed break down of the activities performed at a given work station (figure 3.1). From knowledge of these activities the work station floor area, desk area, and storage space are obtained for the work station and shared space outside the work station. The process is shown in figure 3.2.

To illustrate the process, a set of six sample work station configurations for office workers are presented, using both system and traditional components and following the described procedure.

3.1 Organizational goals

Organizations differ from one to another in many ways. They have distinctive purposes, cultures, histories, and values. These properties are reflected in the organizational goals and approved methods of achieving these goals. A clear and explicit statement of the overall goals provides the appropriate starting point for the process of ultimately defining particular job categories.

3.2 Generic job categories

In the past, there were clear cut distinctions among job categories: clerical, secretarial, professional, etc., where logical boundaries separated the tasks into easily definable categories. While overlapping functions have existed for many years, these distinctions are becoming more blurred as a result of changes in office technology. Managers can now access information developed by professionals; professionals, using word processing software, prepare draft reports for secretaries to edit and communicate with colleagues by means of electronic mail.

As workers engage in a variety of activities at the work station, they need space and furnishings to support different types of work. This is in contrast to the traditional office where work type was relatively fixed and environmental conditions could be designed for a relatively stable office.

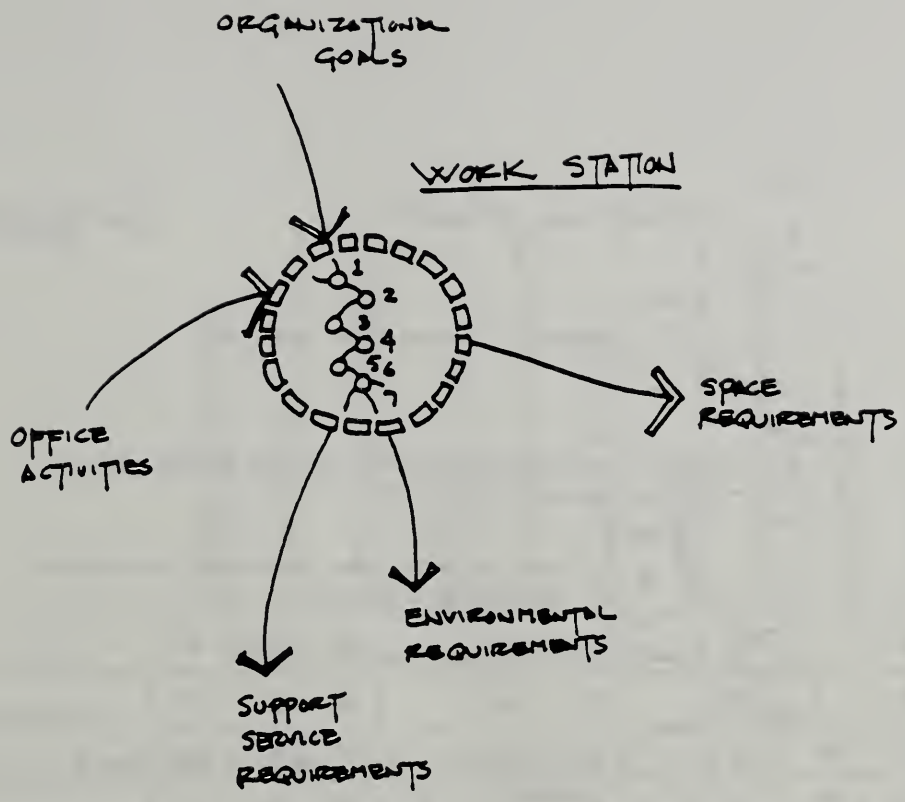


Figure 3.1
Information flows in work station planning

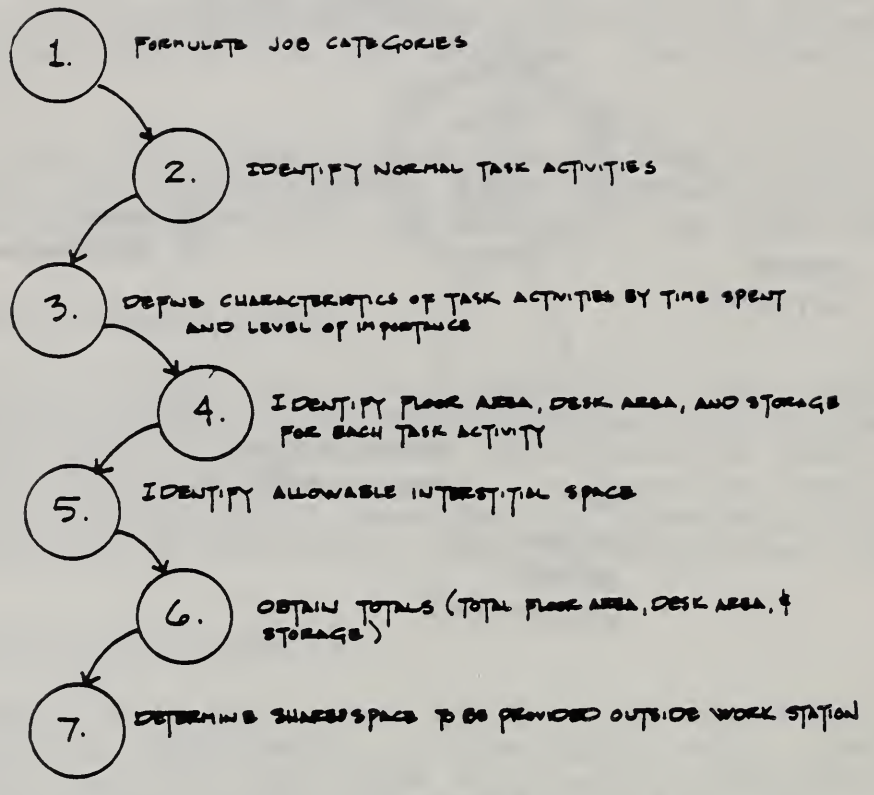


Figure 3.2
Work station space allocation process

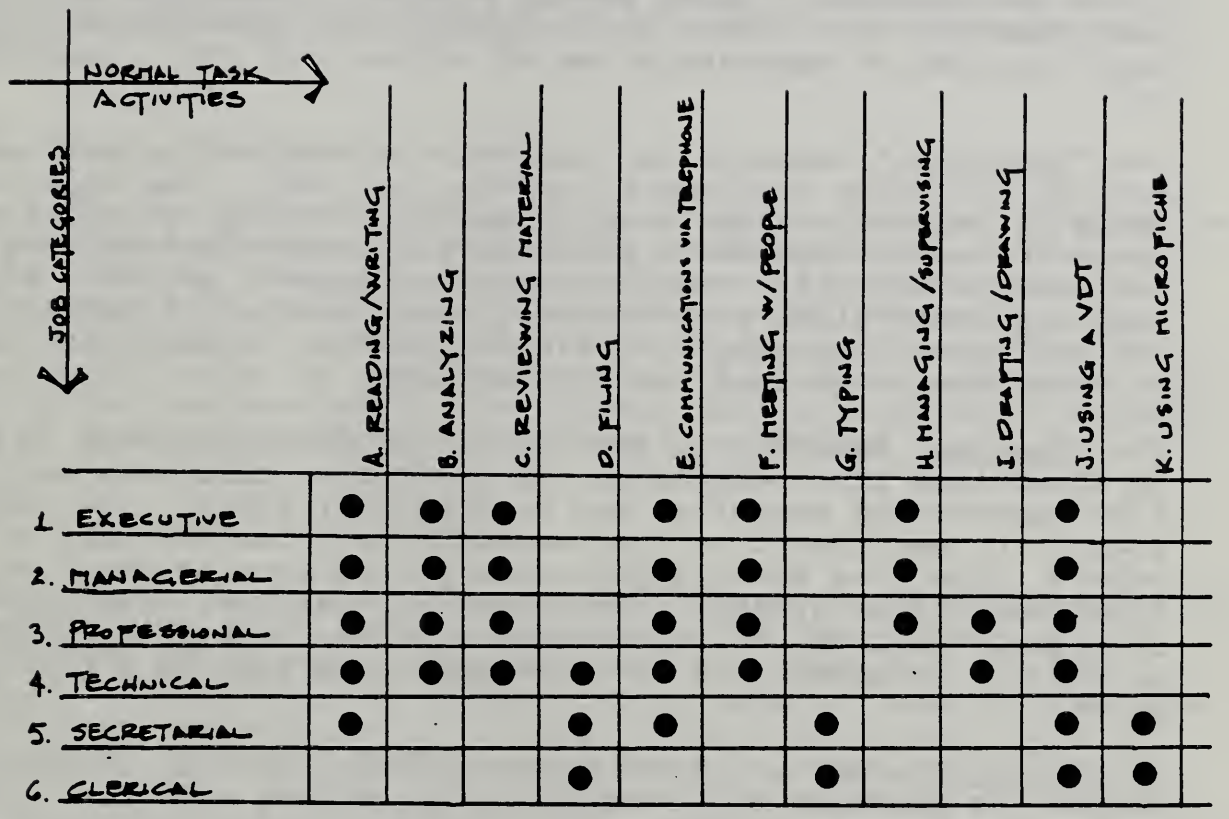


Figure 3.3
Normal task activities by job

Despite the obscured distinctions among traditional job categories, office work is performed by people with varying responsibilities, training, education and skill levels. Since organizations differ from one another, job specifics are not identical, but many commonalties exist. These common features form the bases for grouping jobs into categories. The present objective is to develop a limited set of categories, covering many, but not all office jobs. In this way some general recommendations are possible. Based on the research literature and surveys performed for this study, the following job classifications have been selected as representative of office work (9). (See Figure 3.3)

The "Executive" category can perform a variety of activities from running corporate meetings to working on a VDT. The type of work tends to require a high level of decision making, furnishings and space to accommodate small meetings with staff and visitors, an environment that is conducive to conversational privacy, and surroundings that allow some recognition of status. Since use of a VDT and other technologies are also possible, a mechanism should be available to account for this as well.

The "Manager" category is similar to the executive, but is likely to spend less time performing administrative functions and more time supervising technical and professional staff. The common feature of management is the responsibility for the work of others. The time spent supervising and performing other activities can differ greatly, therefore this category also needs to be broadly defined. A "managerial" job can be virtually the same as that of an executive, or conversely, the same as a professional.

Professional work is also difficult to describe due to the large variety of possible task activities associated with it. Like the previous categories, professional activities can encompass the range from being largely managerial, but with a large analytical component, to mainly technical, but with a managing/ supervising component. In general, professionals tend to spend more time performing reading/ writing and analytical functions than the other categories.

Technical work covers the range of activities between professional and secretarial, but has an added feature in that technical activities tend to be much more narrowly defined when compared with professional activities, e.g. data entry, telephone reservations, preparation of working drawings.

Secretarial activities include a strong typing or word processing component (use of VDT), with filing and communicating with others often of equal or greater importance. Secretarial activities can be highly automated or completely manual. For the automated activities, sufficient space must be provided.

Clerical activities might suggest a minimal work station size or a fairly large work station, depending on the work done at the work station and the amount of time spent performing work outside the work station. It is not unusual for clerical activities to be performed at common-use areas doing shared-use activities (copying, collating, mail sorting, etc.).

Once the generic job categories are defined, the process of translating these characteristics into space requirements can begin.

3.3 Space allocation procedure

The following procedure draws upon several sources of information to provide a process for estimating work station space requirements based on occupant work activities. From these space requirements work station configurations can be generated. The work sheets that are provided are meant to provide a structure from which revisions and refinements can be made. As more information becomes available, the numbers that are currently suggested as possible ranges can and should be refined.

3.3.1 The overall procedure

The procedure provides a tool for assigning space requirements by breaking down space needs according to the type of activities performed. Once organizational goals have been set and job categories defined, the process can be used to create worksheets which describe each job according to the type of work activity performed. The work sheets are a means of translating work activities into needed furnishings and technologies, which in turn, prescribe space requirements. Designers and space planners can use the space requirements to lay out the particular work station configurations that combine the space requirements with the many other environmental considerations necessary.

One of the key elements here is the focus on the work done at the work station, using the types of activities performed as the basis for allocating space. A preliminary survey of office workers suggested the use of eleven generic office tasks requiring office space (Sheet 1). Using the job/activity matrix suggested in figure 3.3, "customized" job types can be developed by varying the level of importance and time spent for each activity. While generic task activities do not represent all possible types of office work, they were found to cover the bulk of the activities normally performed. Furthermore, the procedure provides for other activities to be added as necessary.

Once a job category and its associated activities are identified, the next step is to select the category for the time spent at each. Work sheets 2A through 2K use this information to determine space requirements for the eleven task activities. For some tasks (such as talking on the telephone) the same space requirements are specified for all activity levels, while for others (such as time spent on a VDT) the amount of space needed for additional equipment is associated with amount of time spent performing the activity. For example, if drafting is a part of the normal work activities, but is performed only occassionally, it may be feasible to locate the drafting table outside the work station. On the other hand, this solution would not be acceptable if drafting were performed more often.

The work sheets allow individual space requirements to be identified by activity and are grouped into four categories: 1) items that require a given floor area footprint, 2) items that require desk top surface space, 3) items that require drawer storage, and 3) items that require shelf storage. Furthermore, space requirements fall into one of two larger groupings; those requirements accomplished within the work station and those that are not. The latter requirements are still necessary, but can be located outside the work station in common or shared spaces. When added to the interstitial space from Sheet 3, and totaled on Sheet 4, the total definable space requirements are obtained.

3.3.2 Sheet No. 1: Identification of normal task activities

The first work sheet identifies the normal office activities that are likely to occur within the work station for each job category. By establishing the types of activities and a level of use for each, it is possible to begin determining the necessary space. Here also it is possible to identify the level of importance for a given task. This can be useful in determining if it is feasible to share resources or locate certain activities outside the work station.

The rationale associated with Sheet No. 1 stems from surveying office workers (both federal and non-federal) on the types of work activities they normally do. With few exceptions, it was possible to itemize their work into the eleven categories shown. Although workers often do several things at their work station, some are more important than others, and the time spent on each is not the same. Hence, columns for identifying the importance (high or low) and the amount of time performing each activity are provided. Such a breakdown has space implications. For example, workers who rarely use a VDT may not need to have it located within their work station, while those that use a VDT much of the day not only need to have it within the work station, but need to have extra space for equipment and storage.

3.3.3 Sheet No. 2: Space requirements for individual tasks

There are space requirements sheets (sheet No. 2A through 2K) for eleven normal office tasks. For each, the activity level dictates what requirements are recommended. For example, Sheet 2A, Reading/ Writing, all three activity levels (low, medium, and high) suggest the need for desk top and at least one storage drawer. For medium use, an additional storage drawer and up to two storage shelves are recommended. For high use, more storage drawers and shelves are suggested.

This example points out another important feature, the use of ranges in the requirements. The desk area on Sheet 2A shows a range of dimensions from 25 to 36 inches in depth (D) and 60 to 75 inches in width (W). Desk top dimensions that fall within this range, such as 30Dx70W, should be acceptable.

Futhermore, asterisks (*) to the right of values indicate that the requirement can be located outside the work station. The task is part of the job, but it is not necessary that the task be performed within the individual work station. In this way it is possible to suggest that some of the space be shared if feasible.

3.3.4 Sheet No. 3: Interstitial space

Sheet No. 3 attempts to account for the space between components in the work station. Interstitial space, as used here, is the remaining floor space excluding tables, desks, files, visitor chairs, and other furniture. This space is needed for such things as movement into and out of the work station, space for drawers to open, chairs to extend, and general access to stored materials. Interstitial space can vary widely. For work stations that approach "cockpit" configurations (figure 3.4) with little additional room other than for movement in and out of the work station, the interstitial space can be as low as eleven square feet. In surveying work stations (from both federal and non-federal buildings), those having such small interstitial space were often only occupied for short periods of the day. Once the interstitial space reached between 13 and 15 square feet (figure 3.5), the work stations tended to be more acceptable for permanent occupancy. A larger range in interstitial space is specified for technical occupants and above, since there is more variation in equipment and storage needs. Also, administrators and managers who have small meetings with one or two additional people within their work station usually require more interstitial space (figure 3.6).

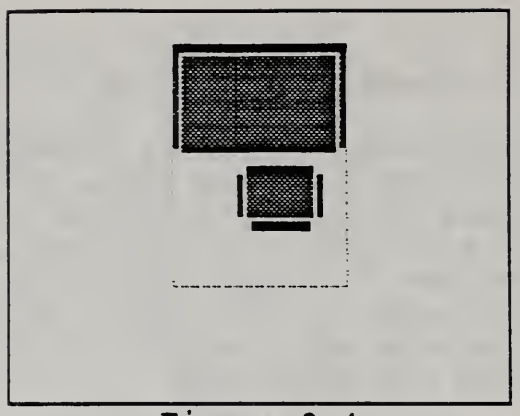


Figure 3.4
Work station with 11 s.f. of
interstitial space.

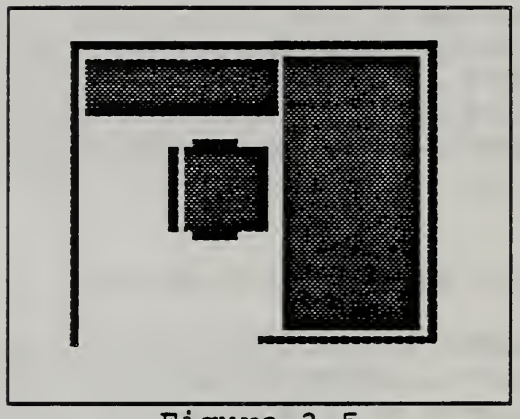


Figure 3.5
Work station with 15 s.f. of
interstitial space.

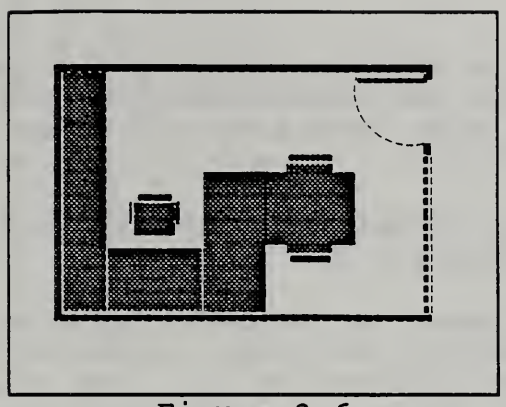


Figure 3.6
Work station with 65 s.f. of

interstitial space.

3.3.5 Sheet No. 4: Summary of requirements

The last work sheet summarizes the individual space requirements. The subtotals from Sheets 2A through 2K and Sheet No. 3 are itemized here. Sheet No. 4 provides an overall tally of the requirements that determine the net work station space needs. Finally, the total definable floor area, minimum work station floor area, and storage requirements are computed on this sheet. The total definable floor area (the work station footprint) is computed as the sum of both the floor areas and the desk surface areas since desk space is assumed to occupy an equivalent amount of floor space. Note that the total definable floor area includes the minimum floor area within the work station as well as the floor area for activities that are a part of job, but are not necessarily within the individual work station.

3.3.6 Outline of the Process

Figure 3.2 provides a diagram of the steps in the space allocation process. There are seven steps suggested here, six that lead up to defining allowable space requirements and a seventh that determines which the requirements will be located within the work station and which will be located in common (shared) areas. Since the requirements within the work station and those not necessarily there are treated separately, some (or all) of the latter could be located within the work station if there is not sufficient sharing of space to warrant treating it outside.

Step 1 Using the organizational goals and office activities, formulate job categories for each work station, classifying them according to the categories shown in figure 3.3.

Step 2 Identify normal task activities for each job category using figure 3.3.

Step 3 Define characteristics of task activity, activity level (low, medium, or high, according to time spent at task as shown in Sheet No. 1), and relative importance (low or high) for each normal task activity.

Step 4 For the normal task activities (Sheets No. 2A through 2K) that apply and the activity levels from Step 3, identify an allowable floor area, desk area, number of storage drawers, and/or number of storage shelves for items listed, observing the footnotes. For most cases, a range is provided: allowable values are any value within this range.

Step 5 Identify an allowable floor area for interstitial space and occupant chair from Sheet No. 3.

Step 6 Transcribe individual task totals from Sheets 2A through 2K to Sheet No. 4, and obtain total requirements necessarily in the work station (labelled as a through d) and not necessarily within the work station (labelled e through f).

Step 7 Of the space requirements that are not necessarily located within the work station, determine the amount that could be maintained within the work station. This is a judgement call, based on the number of common (shared) activities and the linkages between work stations.

At the completion of Step 7, the minimum work station floor area, the minimum desk top area, the minimum number of desk drawers, and the minimum number of shelves should be known. Also known are the same figures for common (shared) activities. With this information, along with furniture characteristics, the designer or space planner should be able to configure a particular work station layout.

Sheet No. 1

Normal Office Tasks/Activities	Importance	Activity Level N No use	L Low Use	M Medium Use	H High Use
A. Reading/Writing	Low/High	Never	Rarely	<2 hrs/day	>2 hrs/day
B. Analyzing	Low/High	Never	Rarely	<2 hrs/day	>2 hrs/day
C. Reviewing material	Low/High	Never	Rarely	<2 hrs/day	>2 hrs/day
D. Filing (hard copy material)	Low/High	Never	Rarely	<2 hrs/day	>2 hrs/day
E. Communications via telephone	Low/High	Never	Rarely	<2 hrs/day	>2 hrs/day
F. Meeting with people	Low/High	Never	Rarely	<2 hrs/day	>2 hrs/day
G. Typing	Low/High	Never	Rarely	<2 hrs/day	>2 hrs/day
H. Managing/Supervising	Low/High	Never	Rarely	<2 hrs/day	>2 hrs/day
I. Drafting/Drawing	Low/High	Never	Rarely	<2 hrs/day	>2 hrs/day
J. Using video display terminal	Low/High	Never	Rarely	<2 hrs/day	>2 hrs/day
K. Using microfiche	Low/High	Never	Rarely	<2 hrs/day	>2 hrs/day

Sheet No. 2.A

	READING/WRITING	Activity Level L	M	H	Floor Area	Desk Area	Storage Drawers	Storage Shelves	Notes
1	Desk top for paper materials	x	x	x		25-36Dx45-75W			
2	Drawer storage for materials	x	x	x			1		(a) (b)
3	Storage for active files			x			1		(a) (b)
4	Storage for archival files		x	x			1*		(a) (b)
5	Storage for books		x	x				0-2	(c)
6	Storage for reference material			x				0-2	(c)
	Necessarily w/in work station ---------->								
	Not necessarily w/in work station ---------->						*		
	Totals:								
	Minimum desk area ----------								
	Minimum storage area ----------								

Footnotes:
(a) File drawer.
(b) Account for legal size material where necessary.
(c) Shelves should be at least 12 inches deep and 30 inches wide.

Sheet No. 2B

	ANALYZING	Activity Level L	M	H	Floor Area	Desk Area	Storage Drawers	Storage Shelves	Notes
1	Desk top work space	x	x	x		20-25Dx45-75W			(a) (b)
2	Storage for active files		x	x			0-1		(a)
3	Storage for archival files			x			0-1*		(a)
4	Storage for books & references			x				0-2	(a) (c)
	Necessarily w/in work station ---------->								
	Not necessarily w/in work station ---------->						*		
	Totals:								
	Minimum desk area ----------								
	Minimum storage area ----------								

Footnotes:
(a) In addition to Reading/Writing requirements.
(b) For low use, include only if other work surface specified.
(c) Shelves should be at least 12 inches deep and 30 inches wide.

Sheet No. 2.C

	REVIEWING MATERIAL	Activity Level L	M	H	Floor Area	Desk Area	Storage Drawers	Storage Shelves	Notes
	Normal & legal paper material:								(a)
1	Desk top work space	x	x	x		20-25Dx45W			(b)
2	Storage for extra reports		x	x	18-24Dx12-48W*				(c)
	Large drawings:								(a)
1	Desk top for large drawings		x	x		36-48Dx48-84W			(b)
2	Storage for rolled drawings		x	x	18-48Dx23-57W*				
	Necessarily w/in work station ---------->								
	Not necessarily w/in work station ---------->				*				
	Totals:								
	Minimum floor area ---								
	Minimum desk area ----------								
	Minimum storage area ----------								

Footnotes:
(a) Include requirements for either normal & legal material or large drawings, not both. If both are performed, assign space for the larger of the two.
(b) In addition to Reading/Writing requirements.
(c) Storage can be vertical or horizontal.

Sheet No. 2.D

	FILING (Hard copy material)	Activity Level L,M,H	Floor Area	Desk Area	Storage Drawers	Storage Shelves	Notes
1	Personal files	x		30Dx40W	3-4		(a)
2	Organizational unit files	x	18Dx30W ea*				(b)
3	Archival files	x	18Dx30W ea*				(b)
	Necessarily w/in work station ---------->						
	Not necessarily w/in work station ---------->		*				
	Totals:						
	Minimum floor area ---						
	Minimum desk area ----------						
	Minimum storage area ----------						

Footnotes:
(a) Include work surface if no other specified.
(b) Account for legal size material where necessary.

Sheet No. 2.E

	COMMUNICATIONS VIA TELEPHONE	Activity Level L,M,H	Floor Area	Desk Area	Storage Drawers	Storage Shelves	Notes
1	Desk top for telephone, modem & note taking	x		20-25Dx45W			(a)
	Necessarily w/in work station ---------->						
	Totals:						
	Minimum floor area ---						
	Minimum desk area ----------						
	Minimum storage area ----------						

Footnotes:
(a) Include if no other work surface specified

Sheet No. 2.F

	MEETING w/ PEOPLE	Activity Level L	M	H	Floor Area	Desk Area	Storage Drawers	Storage Shelves	Notes
1	Chair for 1st visitor		x	x	20-28Dx19-28W			(a)	(b)
2	Chair for 2nd visitor		x	x	20-28Dx19-28W*			(a)	(c) (d)
3	Meeting table		x	x		36-45Dx36-45W*		(a)	(c) (d)
	Necessarily w/in work station ---------->								
	Not necessarily w/in work station ---------->				*	*			
	Totals:								
	Minimum floor area ---								
	Minimum desk area ----------								
	Minimum storage area ----------								

Footnotes:
(a) Where visitors are likely to be outside organizational unit, appearance of work station important
(b) Include for professionals and above.
(c) Include for managers & supervisors.
(d) Where meetings of confidential nature, acoustically private environment necessary.

Sheet No. 2.G

	TYPING	Activity Level L	M	H	Floor Area	Desk Area	Storage Drawers	Storage Shelves	Notes
1	Desk top space for typewriter	x	x	x		18Dx42W*			(a)
2	Storage of forms		x	x			0-2	0-1	(b) (c)
	Necessarily w/in work station ---------->								
	Not necessarily w/in work station ---------->					*			
	Totals:								
	Minimum floor area ---								
	Minimum desk area ----------								
	Minimum storage area ----------								

Footnotes:
(a) For rare use, typewriter can be located outside work station.
(b) Include if secretarial work station.
(c) Shelves should be at least 12 inches deep and 30 inches wide.

Sheet No. 2.H

	MANAGING/ SUPERVISING	Activity Level L	M	H	Floor Area	Desk Area	Storage Drawers	Storage Shelves	Notes
1	Desk space for paper material		x	x		22-24Dx60-120W			(a) (b)
2	Storage for reference material			x				0-2	(c)
3	Storage for paper files			x			0-2		(d)
	Necessarily w/in work station ---------->								
	Not necessarily w/in work station ---------->								
	Totals:								
	Minimum floor area ---								
	Minimum desk area ----------								
	Minimum storage area ----------								

Footnotes:
(a) Conversational privacy may be critically important for many managerial tasks.
(b) For tasks involving meetings w/ others, see Sheet 2F.
(c) Shelves should be at least 12 inches deep and 30 inches wide.
(d) Account for legal size material where necessary.

Sheet No. 2.I

	DRAFTING/ DRAWING	Activity Level L	M	H	Floor Area	Desk Area	Storage Drawers	Storage Shelves	Notes
For manual drafting/ drawing:									
1	Drafting/drawing table space	x	x	x		36-44Dx48-84W			(a)
2	Desk space for large drawings			x		24-36Dx70W			
3	Storage for rolled drawings		x	x	18-48Dx23-57W				
4	Storage for equipment			x			1-2		
For Computer-Aided Drafting:									
5	Desk Top for monitor & keyboard	x	x	x		30-45Dx19-45W			(b) (c) (d)
6	Floor space for system unit	x	x	x	19-30Dx7-18W				(b) (c) (e)
	Necessarily w/in work station ---------->								
	Not necessarily w/in work station ---------->								
	Totals:								
	Minimum floor area ---								
	Minimum desk area ----------								
	Minimum storage area ----------								

Footnotes:
(a) If rarely used, can be located outside work station.
(b) System may be in shared location within work station or outside of it.
(c) If CADD not part of current needs, consideration should be to make work station flexible enough to commodate system at later date.
(d) Include desk space for large drawings (above) if no other work surface specified.
(e) Include only for floor mounted system units.

Sheet No. 2.J

	USING Video Display Terminal	Activity Level L	M	H	Floor Area	Desk Area	Storage Drawers	Storage Shelves	Notes
1	Display monitor & keyboard	x	x	x		25-45Dx19-45W*		(a)	
2	System unit (floor)	x	x	x	19-30Dx7-18W*				(a) (b)
3	Desk space for paper materials		x	x		30Dx30W			(c)
4	Storage for manuals & media		x	x				0-2	(d)
5	Storage for computer printouts			x				0-1	(d)
6	Printer & paper		x	x		16-32Dx15-43W*			
7	Pointing device & pad			x		12-24Dx12-24W			
8	External disk drive units			x		12-18Dx10-12W			(e)
9	Second monitor & keyboard			x		30-45Dx19-45W			(f)
10	Support equipment			x	*	*			(g)
	Necessarily w/in work station ---------->								
	Not necessarily w/in work station ---------->				*	*			
	Totals:								
	Minimum floor area ---								
	Minimum desk area ----------								
	Minimum storage area ----------								

Footnotes:
(a) For low activity level monitor, keyboard, and system unit can be located outside work station.
(b) Include only for floor mounted units.
(c) Include if no other work surface specified.
(d) Shelves should be at least 12 inches deep and 30 inches wide.
(e) Include only if secretarial or word processing tasks performed.
(f) Include only for programmers or systems analysts.
(g) Highly variable; size for particular equipment needs.

Sheet No. 2.K

	USING MICROFICHE	Activity Level L,M,H	Floor Area	Desk Area	Storage Drawers	Storage Shelves	Notes
1	Desk top for microfiche machine	x		17-18Dx12-17W*			(a)
2	Storage for media	x				0-1*	(b)
	Necessarily w/in work station ---------->						
	Not necessarily w/in work station ---------->			*		*	
	Totals:						
	Minimum floor area ---						
	Minimum desk area ----------						
	Minimum storage area ----------						

Footnotes:
(a) If rarely used, may be located outside work station.
(b) Shelves should be at least 12 inches deep and 30 inches wide.

Sheet No. 3

INTERSTITIAL SPACE	Activity Level L	M	H	Floor Area ft2	Notes		
Short-term occupancy	x			6-9	(a)	(b)	(c)
Clerical/typist		x	x	7-13	(a)	(b)	
Administrative/secretarial		x	x	13-20	(a)	(b)	
Technical/professional		x	x	18-66	(a)	(b)	
Administrative/managerial		x	x	33-68	(a)	(b)	
Managerial/supervisor		x	x	33-105	(a)	(b)	(d)

Footnotes:
(a) Excludes occupant's chair, visitor chairs, tables, desks, files, and other furniture.
(b) Identifiable work station space only; circulation space outside work station excluded.
(c) Provides only limited amount of desk and occupant movement.
(d) Higher floor areas for enclosed offices where confidentiality critical.

OCCUPANT CHAIR	Activity Level L,M,H	Floor Area	Notes
All occupants	x	20-28Dx19-28W	(a)

Footnotes:
(a) High quality (orthopedic) chair important for those with VDT at M or L level.

Sheet No. 4

SUMMARY

Tasks/Activities	Necessarily w/in work station: Floor Area ft2	Desk Area ft2	Storage Drawers	Storage Shelves	Not necessarily w/in work station: Floor Area ft2	Desk Area ft2	Storage Shelves
A. Reading/Writing							
B. Analyzing							
C. Reviewing material							
D. Filing							
E. Communications							
F. Meeting with people							
G. Typing							
H. Managing/Supervising							
I. Drafting/Drawing							
J. Using VDT							
K. Using microfiche							
Interstitial space							
Occupant chair							
Totals:	a	b	c	d	e	f	g

Total definable floor area needed = (a + b) + (e + f): _____

Minimum work station floor area required = (a + b) ;with requirements (e + f) external to work station.
Vertical storage requirements = (c + g) drawers & (d) storage units.

3.4 Case Studies: Examples of the Space Allocation Procedure

3.4.1 Example 1 (With detailed work sheet break down)

Description: Office Type- Open plan with partial height partitions
Occupant - Professional; performs a variety of functions split equally as shown:

Normal activities	Hrs/day at activity	Use level	Importance
1. Reading/writing	< 2 hrs/day	M	H
2. Analyzing	< 2 hrs/day	M	H
3. Reviewing matl	Rarely	L	L
4. On phone	< 2 hrs/day	M	H
5. Meeting w/ people	< 2 hrs/day	M	H
6. Manage/supervise	Rarely	L	L
7. Drafting/drawing	Never	N	N/A
8. Using VDT	< 2 hrs/day	M	H

Notes:
Although all eight tasks listed in figure 3.3 for professionals are itemized, only five activities are estimated to be important. (This type of information would be determined during the programming phase of the interior design process. The hours per day at each task activity is also determined during the programming phase). The bracketed "[]" numbers are the ones used in the example.

From the summary sheet, the total defined area is found to be 80.8 square feet, with 33 square feet of desk surface, three storage drawers, and four shelves.

A possible work station configuration:
An 8.0 ft by 10.0 ft office with 34 square feet of desk surface area, 4 - 36 inch long binder bins storage units, 3 storage drawers (one on top of another), and a guest chair. Although one of the storage drawers could have been located outside the work station, it was feasible to keep it within the space.

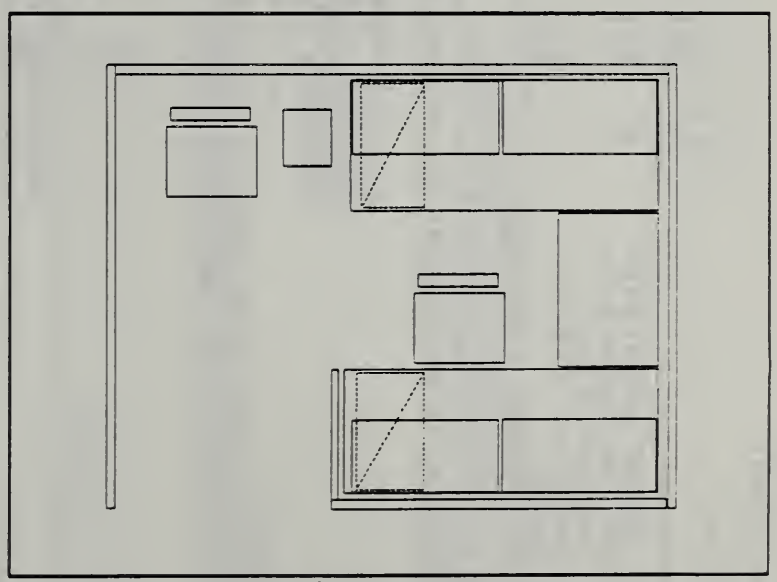


Figure 3.7
Example 1: 8.0 ft x 10.0 ft work station

Example 1 (continued)

Sheet No. 2.A

	READING/WRITING	Activity Level L	[M]	H	Floor Area	Desk Area	Storage Drawers	Storage Shelves	Notes
1	Desk top for paper materials	x	[x]	x		25-36Dx45-75W	[25x70]		
2	Drawer storage for materials	x	[x]	x			[1]		(a) (b)
3	Storage for active files			x			1		(a) (b)
4	Storage for archival files		[x]	x			[1]*		(a) (b)
5	Storage for books		[x]	x				0-[2]	(c)
6	Storage for reference material			x				0-2	(c)
	Necessarily w/in work station ---------->					[25"x70"]	[1]	[2]	
	Not necessarily w/in work station ---------->						[1]*		
	Totals:				[12.15 s.f.]		[2]	[2]	
	Minimum desk area ----------								
	Minimum storage area ----------								

Footnotes:
(a) File drawer.
(b) Account for legal size material where necessary.
(c) Shelves should be at least 12 inches deep and 30 inches wide.

Sheet No. 2B

	ANALYZING	Activity Level L	[M]	H	Floor Area	Desk Area	Storage Drawers	Storage Shelves	Notes
1	Desk top work space	x	[x]	x		20-25Dx45-75W	[25x70]		(a) (b)
2	Storage for active files		[x]	x			0-[1]		(a)
3	Storage for archival files			x			0-1*		(a)
4	Storage for books & references			x				0-2	(a) (c)
	Necessarily w/in work station ---------->					[25"x70"]	[1]		
	Not necessarily w/in work station ---------->						*		
	Totals:				[12.15 s.f.]		[1]		
	Minimum desk area ----------								
	Minimum storage area ----------								

Footnotes:
(a) In addition to Reading/Writing requirements.
(b) For low use, include only if other work surface specified.
(c) Shelves should be at least 12 inches deep and 30 inches wide.

Example 1 (continued)
Sheet No. 2.E

	COMMUNICATIONS VIA TELEPHONE	Activity Level L,[M],H	Floor Area	Desk Area	Storage Drawers	Storage Shelves	Notes
1	Desk top for telephone, modem & note taking	[x]		20-25Dx45W			[(a)]
	Necessarily w/in work station ---------->						
	Totals:			[0- space already included]			
	Minimum floor area ---						
	Minimum desk area ----------						
	Minimum storage area ----------						

Footnotes:
(a) Include if no other work surface specified

Sheet No. 2.F

	MEETING w/ PEOPLE	Activity Level L [M] H	Floor Area	Desk Area	Storage Drawers	Storage Shelves	Notes
1	Chair for 1st visitor	[x] x	20-28Dx19-28W [20x19]			(a)	[(b)]
2	Chair for 2nd visitor	[x] x	20-28Dx19-28W*			(a)	(c) (d)
3	Meeting table	[x] x		36-45Dx36-45W*		(a)	(c) (d)
	Necessarily w/in work station ---------->		[20"x19" = 2.6 s.f.]				
	Not necessarily w/in work station ---------->		*	*			
	Totals:		[2.6 s.f.]				
	Minimum floor area ---						
	Minimum desk area ----------						
	Minimum storage area ----------						

Footnotes:
(a) Where visitors are likely to be outside organizational unit, appearance of work station important
(b) Include for professionals and above.
(c) Include for managers & supervisors.
(d) Where meetings of confidential nature, acoustically private environment necessary.

Example 1 (continued)
Sheet No. 2.J

	USING Video Display Terminal	Activity Level L	[M]	H	Floor Area	Desk Area	Storage Drawers	Storage Shelves	Notes
1	Display monitor & keyboard	x	[x]	x		25-45Dx19-45W*	[25x42]		(a)
2	System unit (floor)	x	x	x	19-30Dx7-18W*				(a) (b)
3	Desk space for paper materials		[x]	x		[30Dx30W]			(c)
4	Storage for manuals & media		[x]	x				0-[2]	(d)
5	Storage for computer printouts			x				0-1	(d)
6	Printer & paper		[x]	x		16-32Dx15-43W*	[16x15]		
7	Pointing device & pad			x		12-24Dx12-24W			
8	External disk drive units			x		12-18Dx10-12W			(e)
9	Second monitor & keyboard			x		30-45Dx19-45W			(f)
10	Support equipment			x	*	*			(g)
	Necessarily w/in work station ---------->					[7.3 + 1.7 = 9.0	s.f.]	[2]	
	Not necessarily w/in work station ---------->				*	*			
	Totals:					[9.0 s.f.]		[2]	
	Minimum floor area ---								
	Minimum desk area ----------								
	Minimum storage area ----------								

Footnotes:
(a) For low activity level monitor, keyboard, and system unit can be located outside work station.
(b) Include only for floor mounted units.
(c) Include if no other work surface specified.
(d) Shelves should be at least 12 inches deep and 30 inches wide.
(e) Include only if secretarial or word processing tasks performed.
(f) Include only for programmers or systems analysts.
(g) Highly variable; size for particular equipment needs.

INTERSTITIAL SPACE	Activity Level L	[M]	H	Floor Area ft2	Notes		
Short-term occupancy	x			6-9	(a)	(b)	(c)
Clerical/typist		x	x	7-13	(a)	(b)	
Administrative/secretarial		x	x	13-20	(a)	(b)	
Technical/professional		[x]	x	18-66[42]	(a)	(b)	
Administrative/managerial		x	x	33-68	(a)	(b)	
Managerial/supervisor		x	x	33-105	(a)	(b)	(d)

Footnotes:
(a) Excludes occupant's chair, visitor chairs, tables, desks, files, and other furniture.
(b) Identifiable work station space only; circulation space outside work station excluded.
(c) Provides only limited amount of desk and occupant movement.
(d) Higher floor areas for enclosed offices where confidentiality critical.

OCCUPANT CHAIR	Activity Level L,M,H	Floor Area	Notes
All occupants	[x]	20-28Dx19-28W [22x19] 2.9 s.f.	(a)

Footnotes:
(a) High quality (orthopedic) chair important for those with VDT at M or L level.

Example 1 (continued)
Sheet No. 4

SUMMARY

Tasks/Activities	Necessarily w/in work station: Floor Area ft2	Desk Area ft2	Storage Drawers	Storage Shelves	Not necessarily w/in work station: Floor Area ft2	Desk Area ft2	Storage
A. Reading/Writing		12.15	1	2			1-drawer
B. Analyzing		12.15	1				
C. Reviewing material							
D. Filing							
E. Communications		0					
F. Meeting with people	2.6						
G. Typing							
H. Managing/Supervising							
I. Drafting/Drawing							
J. Using VDT		9.0		2			
K. Using microfiche							
Interstitial space	42.0						
Occupant chair	2.9						
Totals:	47.5 a	33.3 b	2 c	4 d	e	f	1 g

Total definable floor area needed = (a + b) + (e + f) = **80.8 s.f.**

Minimum work station floor area required = (a + b) ;with requirements (e + f) external to work station.
Vertical storage requirements = (c + g) drawers & (d) storage units.

3.4.2 Example 2 (With summary listing only)

Description: Office Type- Open plan with partial height partitions
Occupant - Secretarial; primarily performs word processing functions, but also performs limited administrative functions:

Normal activities	Hrs/day at activity	Use level	Importance
1. Reading/writing	Rarely	L	L
2. Filing	< 2 hrs/day	M	H
3. On phone	Rarely	L	L
4. Typing	< 2 hrs/day	M	H
5. Using VDT	< 2 hrs/day	H	H
6. Using microfiche	Never	N	N/A

Notes:
For this example it is assumed that communicating on the phone is a low priority activity and that a microfiche is virtually never a part of the job.

The total definable floor area is 43.6 square feet of floor area within work station and 3.8 square feet for filing outside in common areas. The minimum total desk area is 24.2 square feet with two storage drawers and a storage shelf.

A possible work station configuration:
An 8.0 ft by 5.5 ft secretarial work station with a single 30 inch binder bin, typewriter stand, and a larger (30 x 75) desk top for VDT, laser printer, and desk space for occasional writing. Additional file space is used, but since it is shared by others and does not need to be within the work station, it is located in a separate common area.

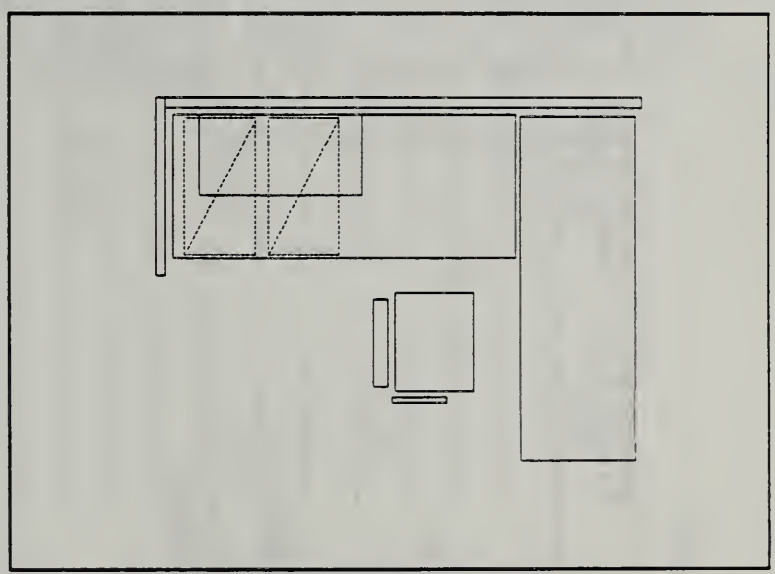


Figure 3.8
A 8.0 ft x 5.5 ft work station

Example 2 (continued)
Sheet No. 4

SUMMARY

Tasks/Activities	Necessarily w/in work station: Floor Area ft2	Desk Area ft2	Storage Drawers	Storage Shelves	Not necessarily w/in work station: Floor Area ft2	Desk Area ft2	Storage
A. Reading/Writing		7.81	1				
B. Analyzing							
C. Reviewing material							
D. Filing	3.75				3.75		
E. Communications							
F. Meeting with people							
G. Typing		5.25	1	1			
H. Managing/Supervising							
I. Drafting/Drawing							
J. Using VDT		11.14					
K. Using microfiche							
Interstitial space	13.0						
Occupant chair	2.6						
Totals:	19.4 a	24.2 b	2 c	1 d	3.75 e	f	g

Total definable floor area needed = (a + b) + (e + f) = 43.6 s.f. + 3.8 s.f. external

Minimum work station floor area required = (a + b) ;with requirements (e + f) external to work station.
Vertical storage requirements = (c + g) drawers & (d) storage units.

3.4.3 Example 3 (With summary listing only)

Description: Office Type- Open plan with partial height partitions
Occupant - Technical draftsperson; performs both manual drafting and computer-aided drafting (CADD) using a VDT at the work station; Analyzing technical material is also a part of the work performed as noted:

Normal activities	Hrs/day at activity	Use level	Importance
1. Reading/Writing	< 2 hrs/day	M	H
2. Analyzing	> 2 hrs/day	H	H
3. Reviewing matl	Rarely	L	L
4. Filing	Never	N	N/A
5. On phone	Rarely	L	L
6. Meeting w/people	Rarely	L	L
7. Drafting	< 2 hrs/day	M	H
8. Using VDT	< 2 hrs/day	M	H

Notes:
It is assumed that reading/writing, analyzing, drafting, and using the VDT are the primary task activities performed in this work station. Reviewing material, communication on the phone, and meeting with people are not treated as a separate activities, having low importance.

The minimum total floor are suggested is 86.6 square feet, with 56.3 for desk area, two drawers, and four shelves.

A possible work station configuration:
A 9.0 ft by 10.0 ft work station with 3-30 inch binder bins, an upright equipment file, desk space for VDT and analysis work, and space for drafting as well as storing drawings. Additional space is specified for computer printer and paper, but since it was assumed that the printer is shared by others via a local area network, it is assumed to be located in an shared space.

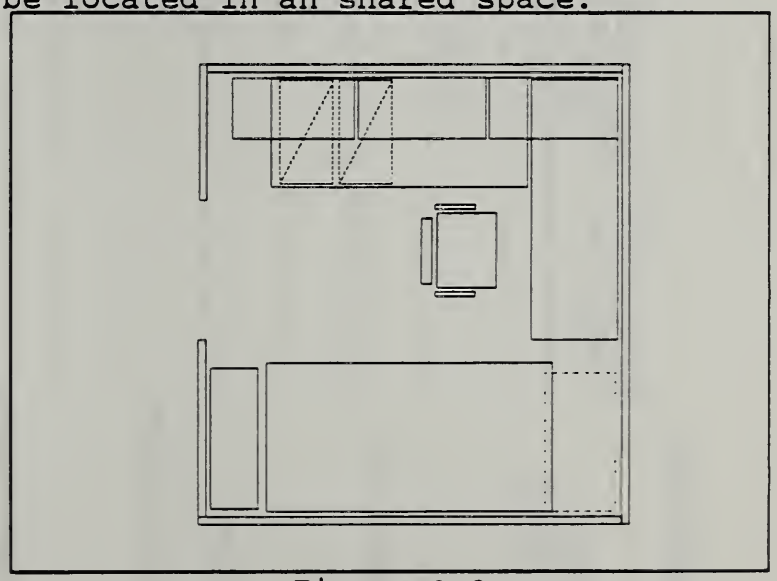


Figure 3.9
A 9.0 ft x 10.0 ft work station

Example 3 (continued)
Sheet No. 4

SUMMARY

Tasks/Activities	Necessarily w/in work station: Floor Area ft2	Desk Area ft2	Storage Drawers	Storage Shelves	Not necessarily w/in work station: Floor Area ft2	Desk Area ft2	Storage
A. Reading/Writing		15.63	1	1			1-drawer
B. Analyzing		6.25	1	2			2-drawers
C. Reviewing material							
D. Filing							
E. Communications							
F. Meeting with people							
G. Typing							
H. Managing/Supervising							
I. Drafting/Drawing	4.69	18.75			3.33		
J. Using VDT		15.63		1			
K. Using microfiche							
Interstitial space	23.0						
Occupant chair	2.6						
Totals:	30.3 a	56.3 b	2 c	4 d	3.33 e	f	g

Total definable floor area needed = (a + b) + (e + f) = 86.6 s.f. + 3.3 s.f. external

Minimum work station floor area required = (a + b) ;with requirements (e + f) external to work station.
Vertical storage requirements = (c + g) drawers & (d) storage units.

3.4.4 Example 4 (With summary listing only)

Description: Office Type- Private enclosed office
Occupant - Middle managerial; performs confidential meetings with staff and outside visitors and spends a large part of the day on a VDT and in reading or writing technical material as noted:

Normal activities	Hrs/day at activity	Use level	Importance
1. Reading/Writing	> 2 hrs/day	H	H
2. Analyzing	Rarely	L	L
3. Reviewing	Rarely	L	L
4. On phone	< 2 hrs/day	M	H
5. Meeting w/people	< 2 hrs/day	M	H
6. Manage/supervise	< 2 hrs/day	M	H
7. Using VDT	> 2 hrs/day	H	H

Notes:
Analyzing material and reviewing material are not treated here as separate activities even though some degree of both is done as part of other work functions.

The minimum total floor area is given as 95.9 square feet, with 40.2 for desk area, two drawers, and seven storage shelves.

A possible work station configuration:
A 10.0 ft by 10.0 ft enclosed office with a 3- 30 inch binder bins, 9 linear feet of shelving and storage, desk space for VDT and analysis work, and space for having confidential meetings with single staff member.

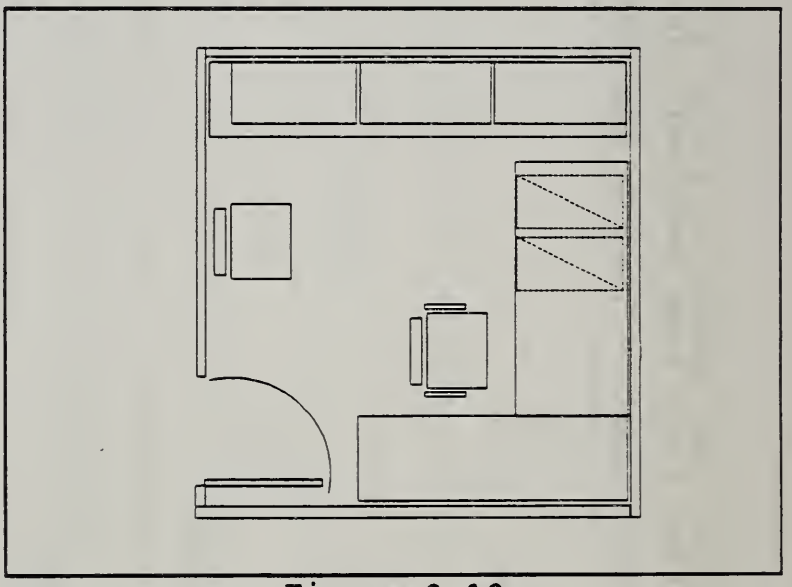


Figure 3.10
10.0 ft x 10.0 ft enclosed office

Example 4 (continued)
Sheet No. 4

SUMMARY

Tasks/Activities	Necessarily w/in work station: Floor Area ft2	Desk Area ft2	Storage Drawers	Storage Shelves	Not necessarily w/in work station: Floor Area ft2	Desk Area ft2	Storage
A. Reading/Writing		14.58	2	4			
B. Analyzing							
C. Reviewing material							
D. Filing							
E. Communications							
F. Meeting with people	2.78	9.00					
G. Typing							
H. Managing/Supervising		*					
I. Drafting/Drawing							
J. Using VDT		16.63		3			
K. Using microfiche							
Interstitial space	50.0						
Occupant chair	2.9						
Totals:	55.7 a	40.2 b	2 c	7 d	e	f	g

Total definable floor area needed = (a + b) + (e + f) = **95.9 s.f.**

Minimum work station floor area required = (a + b) ;with requirements (e + f) external to work station.

Vertical storage requirements = (c + g) drawers & (d) storage units.

* Space needs met through earlier activities, but conversational privacy should be added.

3.4.5 Example 5 (With summary listing only)

Description: Office Type- Open plan with partial height partitions

Occupant - Middle managerial; spends a large part of the day reading, writing & reviewing technical material as noted; although drafting is performed less than 2 hours per day, it is viewed as an important task; meeting with others is not vital part of job, but space is allowed for short informal meetings with one other.

Normal activities	Hrs/day at activity	Use level	Importance
1. Reading/Writing	< 2 hrs/day	M	M
3. Reviewing	> 2 hrs/day	H	H
4. On phone	< 2 hrs/day	M	M
5. Meeting w/people	< 2 hrs/day	L	L
6. Manage/supervise	> 2 hrs/day	H	H
7. Drafting/drawing	< 2 hrs/day	M	H

Notes:
For the most part, material is reviewed at a managerial level, and not analyzed in extensive detail; local confrence room is used when meeting with others where table space is needed.

Total definable floor area given as 173 square feet, with 75.5 for desk area, four drawers, and four storage shelves.

A possible work station configuration:
A 13.5 ft square work station with drafting space, large surface areas for reviewing drawings, and desk space for administrative activities. Extra space for storing large drawings is also provided.

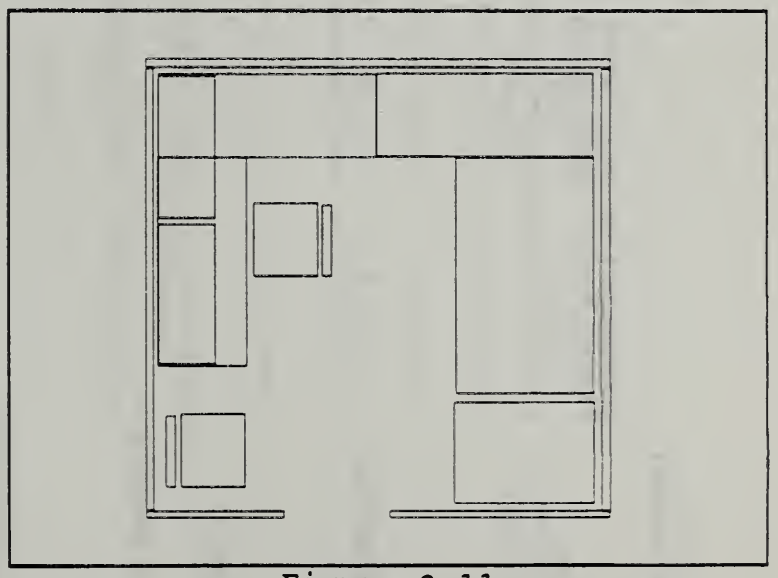


Figure 3.11
13.5 ft x 13.5 ft work station

Example 5 (continued)
Sheet No. 4

SUMMARY

Tasks/Activities	Necessarily w/in work station: Floor Area ft2	Desk Area ft2	Storage Drawers	Storage Shelves	Not necessarily w/in work station: Floor Area ft2	Desk Area ft2	Storage
A. Reading/Writing		15.63	2	2			
B. Analyzing							
C. Reviewing material	12.0	28.0					
D. Filing							
E. Communications							
F. Meeting with people							
G. Typing							
H. Managing/Supervising		10.0	2	2			
I. Drafting/Drawing	12.0	22.0					
J. Using VDT							
K. Using microfiche							
Interstitial space	68.0						
Occupant chair	5.4						
Totals:	97.4 a	75.6 b	4 c	4 d	e	f	g

Total definable floor area needed = (a + b) + (e + f) = 173.0 s.f.

Minimum work station floor area required = (a + b) ;with requirements (e + f) external to work station.
Vertical storage requirements = (c + g) drawers & (d) storage units.

3.4.6 Example 6 (With summary listing only)

Description: Office Type- Private enclosed office
Occupant - Upper managerial; spends a large part of the day in meetings with staff as well as with outside visitors; small confidential meetings often held dealing with sensitive information; reading, writing & reviewing material as noted; VDT used at a managerial level.

Normal activities	Hrs/day at activity	Use level	Importance
1. Reviewing	> 2 hrs/day	H	M
2. On phone	< 2 hrs/day	H	H
3. Meeting w/people	> 2 hrs/day	H	H
4. Manage/supervise	> 2 hrs/day	H	H
5. Using VDT	< 2 hrs/day	M	M

Notes:
Meetings are held both within office (highly confidential) and in remote conference rooms (with larger groups of individuals).

The summary sheet calls for at least 195 square feet of floor area, with 61.8 of that for desk area, and with two storage drawers and four storage shelves.

A possible work station configuration:
A 11 ft x 18 ft fully enclosed office with space for small meetings within office.

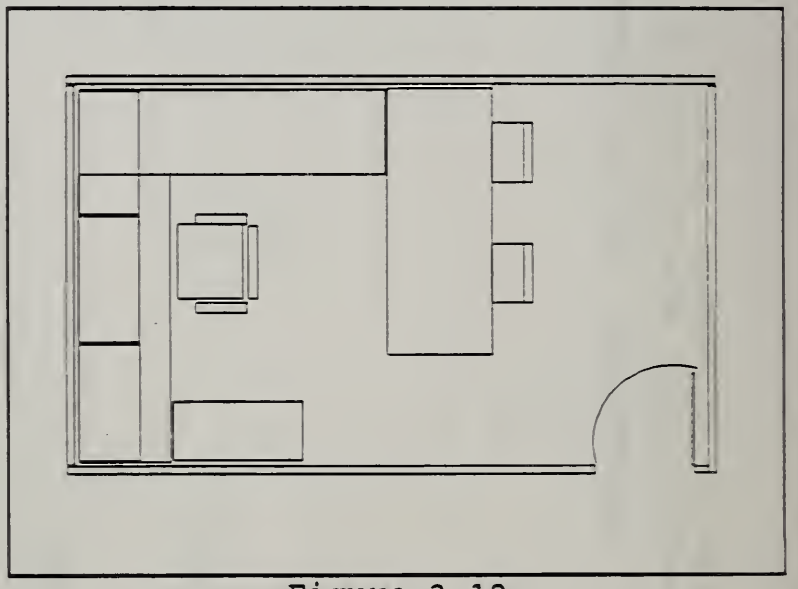


Figure 3.12
11 ft x 18 ft enclosed office

Example 6 (continued)
Sheet No. 4

SUMMARY

Tasks/Activities	Necessarily w/in work station: Floor Area ft2	Desk Area ft2	Storage Drawers	Storage Shelves	Not necessarily w/in work station: Floor Area ft2	Desk Area ft2	Storage
A. Reading/Writing							
B. Analyzing							
C. Reviewing material	8.0	7.8					
D. Filing							
E. Communications							
F. Meeting with people	10.9	14.1					
G. Typing							
H. Managing/Supervising		10.0	2	2			
I. Drafting/Drawing							
J. Using VDT	3.8	29.9		2			
K. Using microfiche							
Interstitial space	105.0						
Occupant chair	5.4						
Totals:	133.1 a	61.8 b	2 c	4 d	e	f	g

Total definable floor area needed = (a + b) + (e + f) = 194.9 s.f.

Minimum work station floor area required = (a + b) ;with requirements (e + f) external to work station.
Vertical storage requirements = (c + g) drawers & (d) storage units.

3.5 Functional relationships and adjacencies

Since buildings are not just a composite of individual work stations, it is necessary to build a network for these in the context of the larger organizational unit. Here the functional relationships among workers, and access to other elements, such as conference rooms and photocopy equipment, needs to be designed into the way the work stations are linked to each other. The functional relationships stem from the work station support requirements, and are used to define the necessary support services (figure 3.13). The other component is to define the space adjacency relationships. Adjacency analysis [16] is one tool useful for understanding these relationships. Here all the common shared elements are incorporated into the space allocation scheme, and it is here where the potentially complex relationships among elements are combined into a whole. The result is an office space layout that meets both the individual functional relationships and the combined spatial adjacencies (figure 3.14).

Figures 3.15 (for separate office space) and 3.16 (for combined office space) are examples of bubble diagrams representing spatial linkages among elements. While the elements themselves are in fact the same in the two diagrams, the implications in terms of the resultant layouts are quite different. The first treats the office spaces as independent elements with barriers to separate them, assuming privacy as the driving factor. The communication link is one-dimensional with all elements using a central spine to communicate with each other. The second bubble diagram is more two-dimensional with more direct communication between elements. Here the office space is a contiguous whole where workers are in direct proximity to each other: communication and access are the driving factors.

Figures 3.17 and 3.18 illustrate possible work station layouts for the respective bubble diagrams. From a space standpoint, it is noteworthy that the open plan arrangement requires substantially less floor space, but allows all the functionality of the enclosed arrangement, and even provides for more storage and desk space through the use of systems furniture.

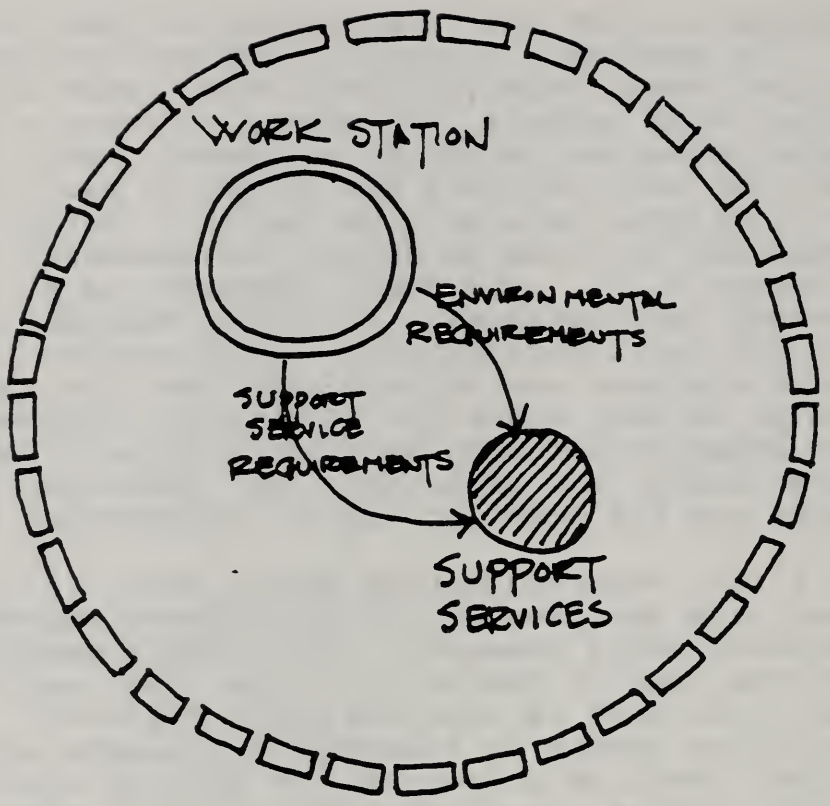


Figure 3.13
Specifying work station support services

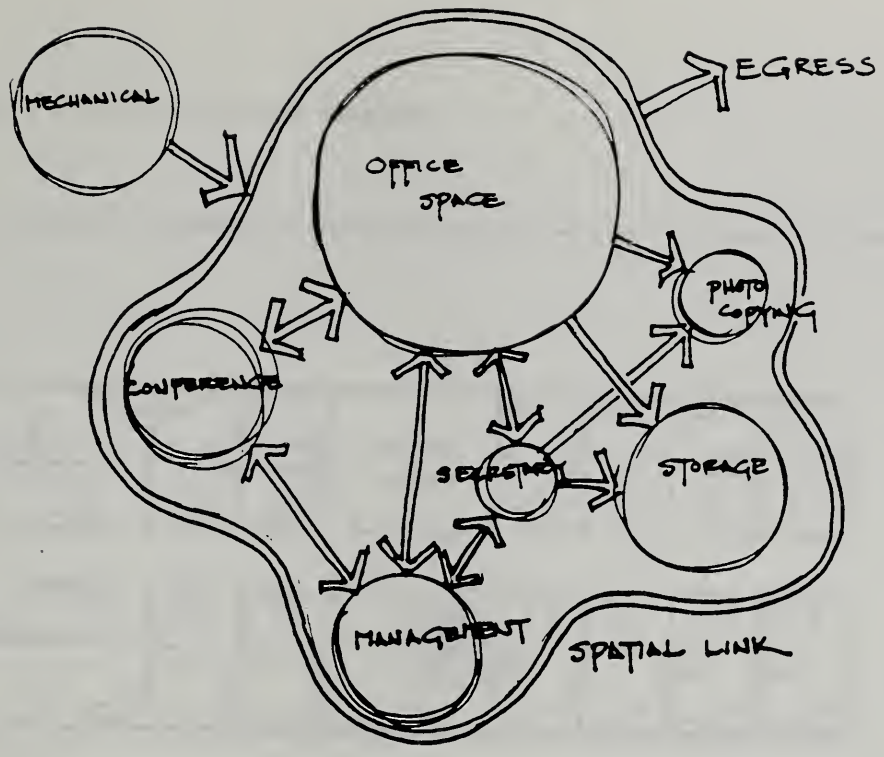


Figure 3.15
Bubble diagram for separate office space

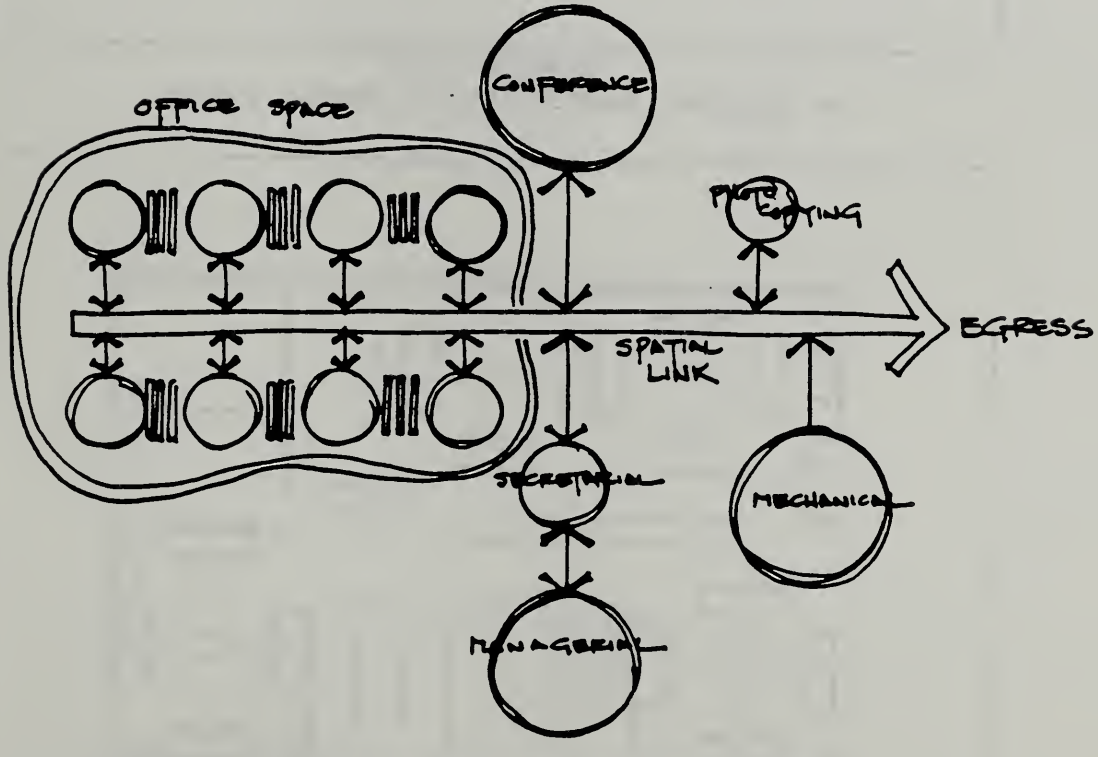


Figure 3.16
Bubble diagram for combined office space

See page 77 for more on the use of bubble diagrams.

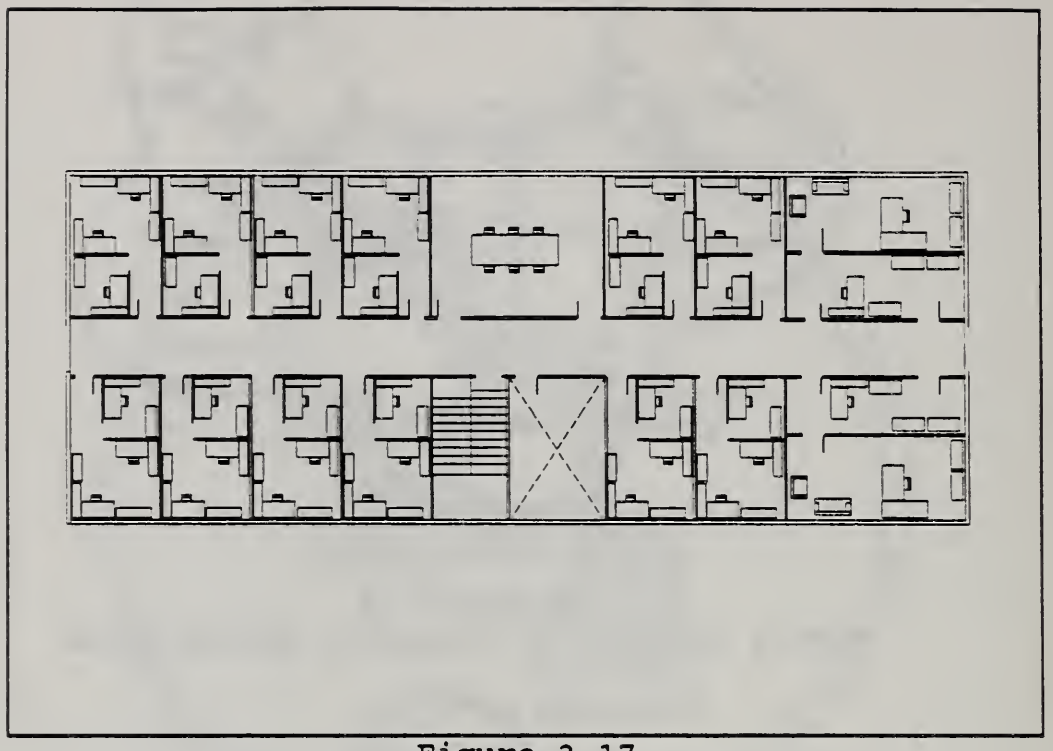


Figure 3.17
A typical conventional space layout

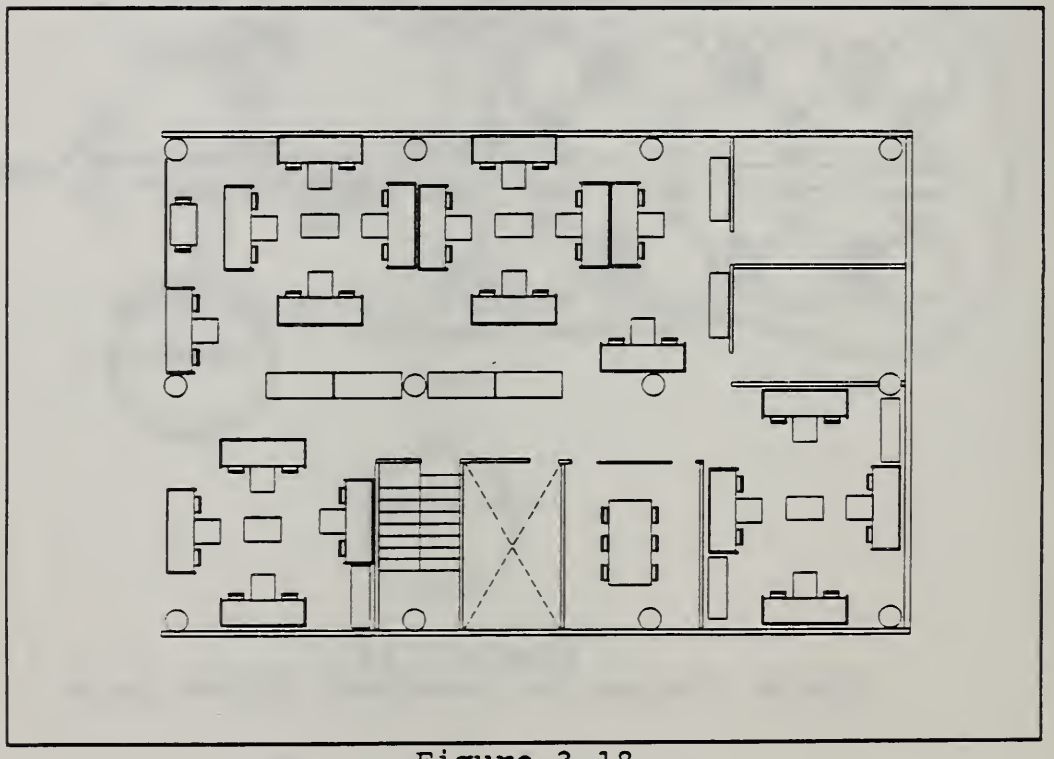


Figure 3.18
Equivalent open plan layout

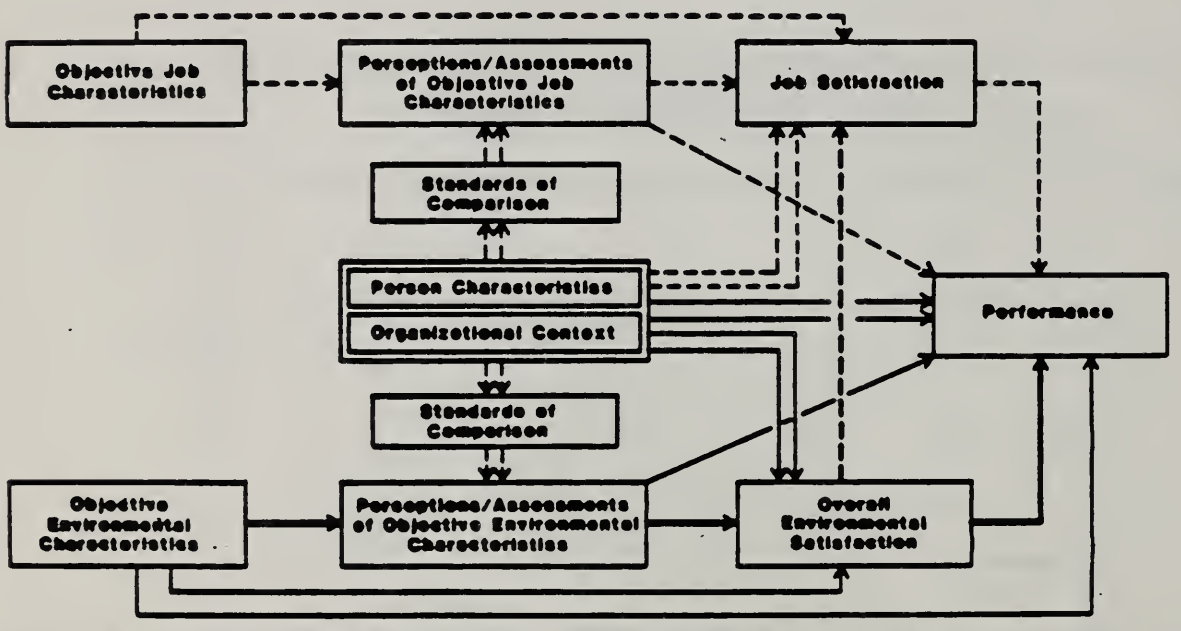
Part 3 Work station issues

Chapter 4 The work station as an organizational tool

An underlying assumption for the present document is that increased office productivity depends on the ability of knowledge workers to fully utilize their expertise and capabilities. This is best accomplished by providing the technical tools and settings for a supportive work environment. (Figure 4.1 describes the factors: personal, organizational and design, which influence job performance.)

All these factors come together at the individual work station. This is the case because information and telecommunication systems advances have brought the power of past mainframe computers to individual office workers. Because of the investment in the tools available at the work station and the salaries paid to professionals and managers, the work performed there must be optimized. Appropriate work station design and furnishings can make an important contribution toward this end.

Figure 4.1 Factors influencing job performance



Note: Solid lines suggest relationship important to environmental designers. Broken lines represent relationships that were not examined within the case study in this article. Double lines denote characteristics of organizations and their individual workers.

4.1 Organizational productivity

Obviously, the individual is not the sole contributor to organizational productivity in the workplace, the working group is also an important entity to be analyzed when assessing productivity. The individuals' activities are often part of a group effort with respect to an identifiable organizational product.

Organizational office productivity can be enhanced in several major ways according to Ellis (10):

1. Provide the tools, spaces, office and environmental systems to facilitate job performance.
2. Eliminate or minimize design and environmental features which make it difficult to operate at optimal performance.
3. Minimize operational "downtime" of work stations resulting from office modifications and required maintenance.

4.1.1 Organizational need analysis

Brady (11) suggests that the following information be collected as a preliminary step in planning office needs:

1. What has to be done?
   - -Task priorities and interfaces
   - -Volume of transactions
   - -Media requirements
   - -Frequency of transactions
   - -Interdependency of tasks
   - -Priority; when performed, immediately?
   - -Number of file cabinets, desks, data in each

2. Who does each task?
   - -Skill level needed
   - -Physical requirements
   - -Value of time
   - -Turnover rate

3. Where should it be performed?
   - -Primary and secondary locations
   - -Supporting requirements
   - -Interdependencies

4. How is the activity performed?
   - -Equipment used
   - -Forms and documentation
   - -Media requirements
   - -Time requirements
   - -User documentation requirements

4.2 Organizational culture

Recent research suggests that while organizational status is still an important determinant of space allocation, the need to accommodate activities, is becoming more important when making decisions about space requirements (12). There is a growing recognition that space limitations can adversely impact job performance and therefore required technologies and materials must be conveniently located at work stations. Furthermore, there is no necessary relationship between organizational status and the amount of such material that must be readily available.

As a substitute for space defining organizational rank, better furniture quality, more choices, and other amenities (e.g. plants, lamps) are being used to delineate status differences in many organizations today.

The furnishings and layout of the office can contribute to a sense of organizational unity as well as departmental diversity. This requires careful tradeoffs between standardization and variety. For example, one criterion for furniture system selection can be standardized components which enable changes to be made easily. Additional features could be a range of colors, panel sizes and material finishes, to distinguish organizational sub-units from one another and provide more variety to the office. The layout of work station groupings can be further integrated to further organizational functions. Common spaces can provide the opportunity for members of diverse groups to exchange ideas, thereby furthering the sense of organizational identity.

Fast changing technology and a competitive environment makes organizational flexibility important. Groupings of people and activities change rapidly and the environment, technologies and furnishings must accommodate these needs.

Organizational culture is frequently reflected by the degree of standardization practiced. Tradeoffs are necessary between the desire to respond to individual tastes and requirements and the requirement for some consistency in overall office appearance, reflecting both aesthetic and economic concerns. These compromises reflect the distinct viewpoints of the end-using organization (to optimize activity performance) and those responsible for facility management.

Rigidly enforced standards reinforce the notion of anonymity of the individual worker. Totally uniform space layouts reinforce the institutional appearance of the office and contribute to a maze-like appearance. Symmetrical patterns of uniform panel heights and colors further accentuate this impression.

On the other hand, a proliferation of different furnishings can give the appearance of disorder, and creates substantial inventory problems when changes are required. Replacement parts and additions to original work station configurations must be

stocked, and part reordering can be a major problem because of frequent changes by vendors in product lines, colors, etc. To the extent that the individual has a "custom-fitted" work station, it becomes virtually impossible to relocate individuals without moving the work station with the person. This approach is contrary to the desire of many organizations to move people instead of moving work stations, which would be a more cost-effective method.

In traditional offices, space allocation was largely determined by job status. Now, equipment and information in its many forms are major factors in making work station space decisions.

The desire for a high quality setting influences work station arrangements. For example, window views are increasingly being considered a shared amenity rather than a perquisite associated with job status. As a result, the layout of work stations and aisles reflect the desirability of enabling as many people as possible to have access to windows.

4.3 Introducing Automation

When technology is introduced into an office setting, it often represents a threat to the work force. Employees are concerned about uncertainties accompanying change, threats to their jobs and lack of knowledge about new electronic systems. A smooth transition to the new environment is needed to overcome these anxieties and minimize work disruption. An approach proposed to accomplish this consists of the following (13):

1. Collect facts, to document automation approach.
2. Start early to announce and explain system, answer questions, share plans, generate enthusiasm and gain long term commitment.
3. Share information with management, support staff and end users.
4. Implement systems gradually; pilot test systems, including factory tests, mockups; communicate results to staff.
5. Be aware of "grapevine" information; make the informal network work for you.
6. Collect information during the entire process; share results.
7. Identify and resolve problems quickly; use experts if needed.
8. Use informal meetings to discuss ongoing developments; maintain staff enthusiasm.
9. Know when to turn the operation over to user groups; with documented procedures, and information about available assistance.

4.4 New office needs

The research performed by the National Institute of Standards Technology (NIST), and elsewhere, has indicated that automation has fostered a variety of new needs in the office (6). Among them are:

1. Exchanging information by informal networking in contrast to formal organizational structures.
2. Places to encourage chance encounters to offset technology.
3. Conference rooms, large and small for meetings requiring privacy and to get away from the VDT dominated work floor.
4. A greater dependency on work groups for intangible benefits such as work satisfaction and job fulfillment.
5. More training facilities to upgrade technologically based skills.

4.5 Training

The experience of many users with office systems, whether word processing, information management or communication, is quite similar. "Black boxes" and/or software packages are placed on the desks of people with virtually no training or experience, with the expectation of immediately improved productivity. The reverse is likely to occur, at least initially. A game of "catch-up" is played by workers faced with performing their regular jobs while simultaneously learning new systems, languages and technologies. Traditional methods are not at hand, and the information typically available to explain the new technology is often written in a language that only computer-programmers find to their taste. Furthermore, end-users are rarely part of the process used to select systems, hardware and software.

4.6. Organizational planning

When the work station is the basic planning unit for office design, the end-user's contribution to the planning process is of critical importance. The analysis of his or her activities form the basis for work station design and configuration. Close involvement of the end-user in planning has many advantages (14):

1. It draws upon the detailed knowledge possessed by the end user in defining system requirements.
2. It provides the user with a 'stake' in the outcome not available when systems are imposed from above.
3. It offsets the uncertainty, fear of loss of job, and the hostility often accompanying the introduction of new technology and other organizational changes.

With the advent of new technologies and the frequencies with which office changes are made, it is more important than ever before for CAD systems to be used whenever possible to keep track

of work station configurations, locations, wiring, power, and communications. Research findings indicate that "churn rates" of 30% per year for work stations are commonplace; maintaining current records of configurations is therefore difficult, but also essential (3).

4.6.1 Feedback information

Prior to making final selections for furnishings, lighting systems and other critical work station design features, many organizations are using mockup configurations to enable users to experience the systems and furnishings. One approach has been to have a variety of configurations, which can be examined by employees, who can evaluate them by examining them and sampling their features.

An even more effective technique is to construct a mockup of a sizable floor area, with all furniture and systems in place, where employees can perform their jobs for several weeks. This would constitute a "real world" test of the proposed work station under actual working conditions. Changes made on the basis of this experience are far less costly that those made after an entire office has been configured and furnished. For example, it can overcome problems such as ambient lighting systems that meet specifications in an unfurnished building, while proving ineffective when work stations are configured, because panels and shelves obstruct light.

Office changes are often incremental, by department. An organization can take advantage of these experiences to gain insights as to features which work and which cause problems. This information can then be fed back into later designs. Little evidence exists that this procedure is employed in many organizations.

4.7 Work station based vs centralized activities

Determining the activities located at individual work stations and those to be centralized are among the most important organizational design decisions. Many factors influence these decisions.

New technologies often are expensive, yet provide faster, higher quality products. In these instances, it is often cost-effective to share this equipment, while providing less expensive functional backups at individual work stations. For example, laser printers are often too expensive for individual use, and therefore are typically shared by organizational groups. Inexpensive dot-matrix printers are now readily available, and are an effective tool for preparing draft documents. Similarly, determining whether individual PC's or terminals should be located at a work station, or whether such devices should be

shared, depends on cost considerations as well how critical they are to the activities performed.

The conduct of private meetings poses a different type of tradeoff. Survey findings suggest that such meetings are a common occurrence among professionals and managers (Unpublished NIST study). Yet, many work stations have neither the space to accommodate them, nor chairs for visitors. Another method of achieving the same purpose is to have several small conference rooms, jointly used by the staff. Studies suggest that the need for such rooms is often underestimated; they are overbooked, and not available on short notice - i.e. when frequently needed most.

Another major office function with considerable impact on space usage concerns the filing of materials; reference works, papers, electronic media, etc. Individuals tend to want as much reference and other material as close at hand as possible; e.g. at the work station. This requires considerable space devoted to file storage. The alternative approach is to centralize files; e.g. by organizational unit, function, type of media. When central filing is used, space adjacency analyses should be used to help determine the best locations. In most instances the appropriate solution combines aspects of central and individual storage approaches.

In determining work station design implications, it is important to know where the work is to be performed. The locations and activities can be grouped as follows:

1. Those best accomplished at individual work stations.
   - Report writing
   - Analytic work
   - Administrative functions
   - Personal communications; telephone calls, memo writing
   - Reading

2. Those which can be performed at individual work stations or at common use facilities.
   - Small meetings
   - Confidential conversations
   - Terminal/PC activities
   - Limited printing; memos, letters
   - Filing of reports, references

3. Those feasible only at common use facilities.
   - Space requirements: large meetings
   - Equipment costs: high speed copying, printing
   - Infrequent use: AV presentations

The characteristics of an organization should strongly influence the decisions to be made in space layout and configuration. The following table indicates the relationship of organizational structure and the design of the office (15).

Table 4.1 Organizational structure and physical environment properties

Organizational Structure	Physical Environment
Size	Space
Technology	Automation
Configuration	Delineation of work-units, rank
Interdependence	Proximity of work-units
Specialization	Differentiation by task, enclosure of task areas, work spaces
Centralization	Uniformity within ranks, jobs, visual accessibility
Formalization	Differentiation by rank, uniformity within ranks, jobs
Standardization	Rigidity of layout

4.8 Organizational adjacency issues

Decisions about work station grouping are also strongly influenced by organizational criteria for adjacencies. Among those employed are:

- Operational groupings
- Open-closed spaces
- Lighting effectiveness; quality, quantity, control
- Lighting; mix of natural and artificial
- Support space effectiveness
- Public - private, responsiveness, accessibility to staff, visitors
- Occupancy- permanent, intermittent
- Criticality to organizational effectiveness
- Number of people occupying space
- Growth potential
- Flexibility
- Finished - unfinished spaces

Chapter 5 Criteria for workspace design

Environmental quality, while becoming more important to office workers, is being compromised by technology and open planning (16). At a time a great demand exists for improved work settings, existing environmental and space conditions are often worse than in traditional offices. These factors, formerly considered tangential to the central importance of salary and professional growth in making job decisions are now important determinants of whether to stay on, or leave a job (4).

The old acceptance of poor working conditions, badly designed equipment and inappropriate environments is disappearing, especially among younger workers. Upgrading existing offices is a valuable part of organizational change and represents a vehicle for changing attitudes and making a new corporate culture visible and meaningful to the staff. Naisbitt (17) makes the further point: "the more technology around us, the more the need for human touch ... the more we'll be looking for ways to reconnect as human beings"

Perceived building quality is therefore likely to become more and more dependent on the degree to which workers can help design and control individual work spaces, furnishings and environmental conditions to suit personalized needs and preferences.

The effective workplace responds to the whole person; including the needs for self esteem, motivation, autonomy, self expression, growth and control. In the high technology workplace it is particularly important to ensure that the worker is the master, not the servant of technology.

A variety of basic needs must be satisfied for people to perform adequately in offices. They include physical comfort, anthropometrics, safety and security, privacy, personal space, contact with others and job satisfaction.

5.1 Basic needs of office workers (18)

5.1.1 Physical comfort and the ambient environment.

The minimum conditions for the ambient environment are thermal comfort, good air quality, adequate lighting to perform work and an acoustic environment which does not interfere with job performance.

5.1.2 Anthropometry

Anthropometry is the study of the "fit" between the person and the furnishings and surrounds in which he or she works. It depends on the physical dimensions and desires of the individual and the physical characteristics of the "things" in contact with

the person. Dimensional considerations also depend upon the activity being performed. The types of data include body dimensions, physical capabilities such as sitting and standing height, reach lengths. The best design reflects economy of effort and minimizing fatigue.

Two approaches can be used to accommodate the need for a variety of dimensions suitable for people with different requirements. One is to provide sufficient adjustability of furnishings and devices to accommodate a range of individual dimensions. The other is to provide alternative means of achieving similar functions; e.g. stairs and a ramp to gain access to buildings.

A vast amount of anthropometric data has been gathered for military and space applications to determine minimal size requirements for aircraft cockpits, submarines, and space capsules. Measurements of individual reach, forces appropriate for control systems and configurations of dials and controls typify the kinds of data available. Other major users of anthropometric information include clothing and furniture manufacturers who employ personal measurement data to appropriately size their products.

While anthropometric information is important for office seating and table heights, it must be used with caution when applied to an office setting. The military and space based data are applicable to settings where seriously confined areas are a "given" and where the working population are highly motivated young adults very carefully selected to perform difficult tasks. These people do not typify the office worker in terms of physical capabilities and the jobs performed.

5.1.3 Personal Privacy

Privacy entails the ability to regulate and control social interactions and avoid interruptions. Visual privacy can be achieved by furnishings, partitions or walls. Acoustical privacy is achieved by masking noise, or enclosures which do not permit sounds to enter the work space. Acoustical privacy (confidentiality) can be apparent rather than real in open settings where the person is surrounded by panels providing visual privacy but sound travels above the partition. The problem has been especially apparent for supervisors having discussions meant to be confidential, yet heard by to staff members in the vicinity.

Sommer (19) described the concept of personal space, as a "bubble" surrounding the individual. The bubble size and configuration define an area, which when intruded upon by another person, results in feelings of discomfort and unease; i.e. an invasion of personal space. The bubble boundaries vary for the individual depending on the activity performed, and from person to person as a result of cultural, individual and other factors.

Beyond the personal space bubble, workers want to exercise control of the "territory" that they occupy; e.g. their office and work station surrounds. This desire for control has been a major cause for concern among people housed in open offices (20). It is manifested by complaints about lack of privacy, opportunities to personalize space, influence the selection of furnishings, and the ability to tailor environmental systems such as lighting.

5.1.4 Orientation and wayfinding

All spatial arrangements and circulation patterns are an outgrowth of the interrelationships of work stations. Circulation space is needed for general office movement as well as within the confines of a work station. These spaces also provide information concerning major and minor pathways. The ability to navigate through a building without getting lost (wayfinding) is especially important when many building users are visitors.

In complex building environments, people rely on environmental cues for moving about and locating organizational units and individuals. In traditional office settings with clearly delineated aisles and private offices, identified by logical numbering systems, visitors are not often confronted with the "wayfinding" problems found in many open offices where panels often obscure major aisles. As a result it is difficult to determine the best path to a destination. Facilitating safe egress from a building is especially important during a fire or other emergency.

Some methods of clarifying an understanding of orientation is the use of clear circulation paths, distinct focal points where paths cross, and clearly differentiated groupings of work stations with identifiable boundaries. Colors, furnishings and textures can be employed to distinguish organizational units. Appropriate signage systems, clearly visible from pathways and focal points, are especially important in environments dominated by standardized work stations as far as the eye can see (21).

Two general schemes can be employed in laying out work stations. One is to have entrances off the aisles, and the other is to have them backing on the aisles. When the entrances are readily accessible, casual visiting is encouraged, and visual and noise disruptions are common. When work stations are positioned with their back walls to the aisle, privacy is maximized. Important factors in making decisions about tradeoffs is the activity being performed, the desirability of fostering casual staff interactions, and whether the aisle is a major office pathway. Another consideration is the number of visitors anticipated; the more traffic, the greater the likelihood of disturbance.

5.1.5 Social interactions

The VDT based work station can isolate staff members from one another since individuals can often function autonomously. Opportunities to facilitate interpersonal relationships among colleagues should be provided to help foster organizational cohesion and identify professional mutual interests. Beyond the pragmatic reasons for promoting staff interaction, the workplace is also a social setting. The quality of worklife is enhanced by the ability to conduct personal conversations in appropriate places.

5.1.6 Status

A traditional organizational status symbol has been the space and furnishings associated with particular jobs. While it is important for the work station configuration to facilitate

performance, it should also be consistent with organizational culture.

5.2 Ergonomics and design

From an ergonomic standpoint, the work station is the domain of the individual and must be planned and designed to meet a variety of requirements. User anthropometry, physical and sensory capabilities and limitations and the cognitive requirements of particular jobs must be considered in its design. The placement of components, equipment and furniture requires consideration of how the body moves, and physical comfort needs. The size of individual components, clearances, and allowances for movement, are all integral to the proper fit of the person to the work station (22).

Automation is often based upon uniform requirements. Yet, individuals, organizations and activities differ from one another in important ways, and have distinctive needs. They have unique characteristics which merit design attention, and it the function of the design process to develop the information needed to respond to them.

The concept of the 'average person' has been discarded by most researchers and many designers. Individuals have a wide variety of sizes and shapes, and have different preferences for equipment and furnishings. As the design of the office must be flexible, furniture must be adjustable. Seat, keyboard, display, and foot support are interacting system components in work station design. Chairs ought to be supported on four legs (or a pedestal with a five caster base), have adjustable seat pans and backrest heights. The angles of seat pans and backrests should be adjustable relative to each another. Backrests ought to be modifiable front and back, with respect to the seat pan. Footrests, adjustable in height, angulation, and front and back distance are also desirable (23).

5.3 Work station criteria

5.3.1 Functional

1. Vertical and horizontal surfaces for materials use and storage; place for continuous paper supply and output
2. Power and communications capabilities consistent with performing required activities
3. Ready access to work materials
4. Work station layout to facilitate performing activities
5. Individual controls for equipment and selected environmental features, e.g. task lighting
6. Easily reached controls; easily read displays
7. Sufficient space to facilitate comfortable movement
8. Integration of task functions
9. Layout of work space consistent with tasks
10. Adjustable VDT screens and detachable keyboard

11. Adequate work surface
12. Physical separation of unrelated activities
13. Ergonomic chair: adjustable, with proper back support

5.3.2 Personal

1. Capability for personalizing work space
2. Acoustic privacy
3. Freedom from auditory and visual distractions
4. Glare-free lighting
5. Non-disruptive traffic patterns
6. Clearly defined personal boundaries

5.3.3 Facility Management

1. Flexibility to accommodate the range of tasks performed and the individuals performing them.
2. Capability for rapid changes and moves
3. Ease of power and communication changes and additions.
4. Modular furnishings; readily modified, moved.
5. Readily maintained furnishings and equipment

5.4 VDT Ergonomic requirements

The VDT keyboard and display is rapidly replacing the typewriter, and is the heart of the modern work station. A broad range of communications capabilities, voice, text, images and data has replaced the standard telephone. The VDT terminal in combination with the latest communications based devices has given the person at a work station an enormous range of potential tools to perform work. The peripheral equipment used for inputting information at the work station ranges from keyboards, light pens and mouses.

5.4.1 Checklist - VDT/Keyboard Requirements (4):

1. Movable and connected keyboards for individual convenience and/or preference
2. Readily adjustable VDT screen- capability to tilt, move vertically, swivel toward or away from the operator
3. Keyboard which enables operator's hands and elbows to be in comfortable positions
4. Work surfaces at preferred height and distance for individual ease of manipulation, support or forearms, palm and wrist, and convenience for seeing the task.

Table 5.2 Summary of main interactions between VDT's systems and environment (24).

Component	Environment	Problem	Impact
Display screen	Lighting	Vision	Fatigue, discomfort glare, reflections
Keyboard	Seating	Posture	Fatigue, awkward posture, poor control location
Printers	Acoustics	Noise	Distraction
	Thermal	Discomfort	Distraction; thermal discomfort
Wiring	Floor area	Safety	Trailing wires, tripping hazard, unsightly

Chapter 6 Work station groupings; environmental context

The primary goal of space planning is to convert functional program requirements into a workable, aesthetically stimulating environment. Some functions and work flows are best accommodated by large open spaces while others are better achieved in smaller, closer sub-units. The spatial layout and the desired spatial quality should reflect relationships among activities. If functions are unrelated, separations in either space or time are required to eliminate confusion.

A consideration of the environmental context for work stations includes a broad range of interdependent issues:

- Office components
- Wire management
- Special interior design elements
- Wall covering materials
- Flooring materials
- Ceiling materials
- Window treatment
- Signage, art

Furniture systems
- General use furniture
- Upholstery fabric

6.1 Work station groupings

In planning offices, a variety of factors should be considered:

1. Efficient space utilization.
   - Evaluate the technological and personal needs to perform specific activities. Determine the dimensional requirements for work stations associated with furnishings and working tools.
2. Adjacency priorities.
   - Develop planning priorities that include activity and comfort considerations, code requirements and social dimensions.
3. Future needs.
   - Consider the potential for expansion/contraction, technological and organizational changes, with regard to potential space impacts.
4. Flexibility.
   - Plan systems, furnishings, electrical, mechanical, HVAC, communication and information system capabilities with sufficient flexibility to accommodate current needs and anticipated changes.
5. Personalization.
   - Permit workers to tailor their spaces with some regard for individual expression.

6. Status.
   - Understand the role of people in the organization and their need to embody that image.
7. Reflect organizational goals and culture.
   - The office and work stations should be consistent with the image of the organization. (25)

6.2 Office design approach - open/closed

While the trend in office design has been toward more open office systems, recently several organizations, e.g. IBM, have reverted to traditional private offices for certain activities. Perhaps the predominant approach is that of mixed systems; managers and senior professionals in private offices, and others in open-plan work stations. Regardless of the approach employed, work station planning based on the activities performed is equally applicable. A recently completed study suggests the following advantages and disadvantages to open and closed offices (26):

Table 6.1 Comparison of Open and Closed Office Tradeoffs

Open office

Advantages	Disadvantages
Greater flexibility	
Initial construction cheaper	Noise distractions
Better space utilization	Standardized furnishings
Ease of communication with co-workers	Lack of status
	Greater parts inventory
Easier supervision of staff	Furniture maintenance problem
Improved circulation	
Easier to group people working together	Lack of privacy; visual & acoustic
Good power and cabling systems	Confidential meetings difficult
Lighter and airier	Difficult to balance HVAC system

Traditional (private) office

Advantages	Disadvantages
Greater privacy; visual/acoustic	Less group interaction
Customizing furnishings easier	Lack of flexibility
Improved status	Longer construction time
Less noise	More individual isolation
Better security	Higher costs
Greater feeling of permanence	Costly to reconfigure
Clutter not visible	Inefficient space utilization
Confidential discussions easier	Higher electrical, HVAC costs

6.3 Functional groupings of organizational elements

One reason for performing a space adjacency analysis is to minimize the time spent by workers moving from place to place in performing an activity. Another one is that proper adjacency relationships can foster communication among individuals and groups.

The organization of work stations into functional and administrative units has important implications for space layout, special purpose spaces, environmental systems and furnishings. First consider some reasons for space adjacencies, emphasizing those for locating work stations near one another or to jointly used facilities and materials:

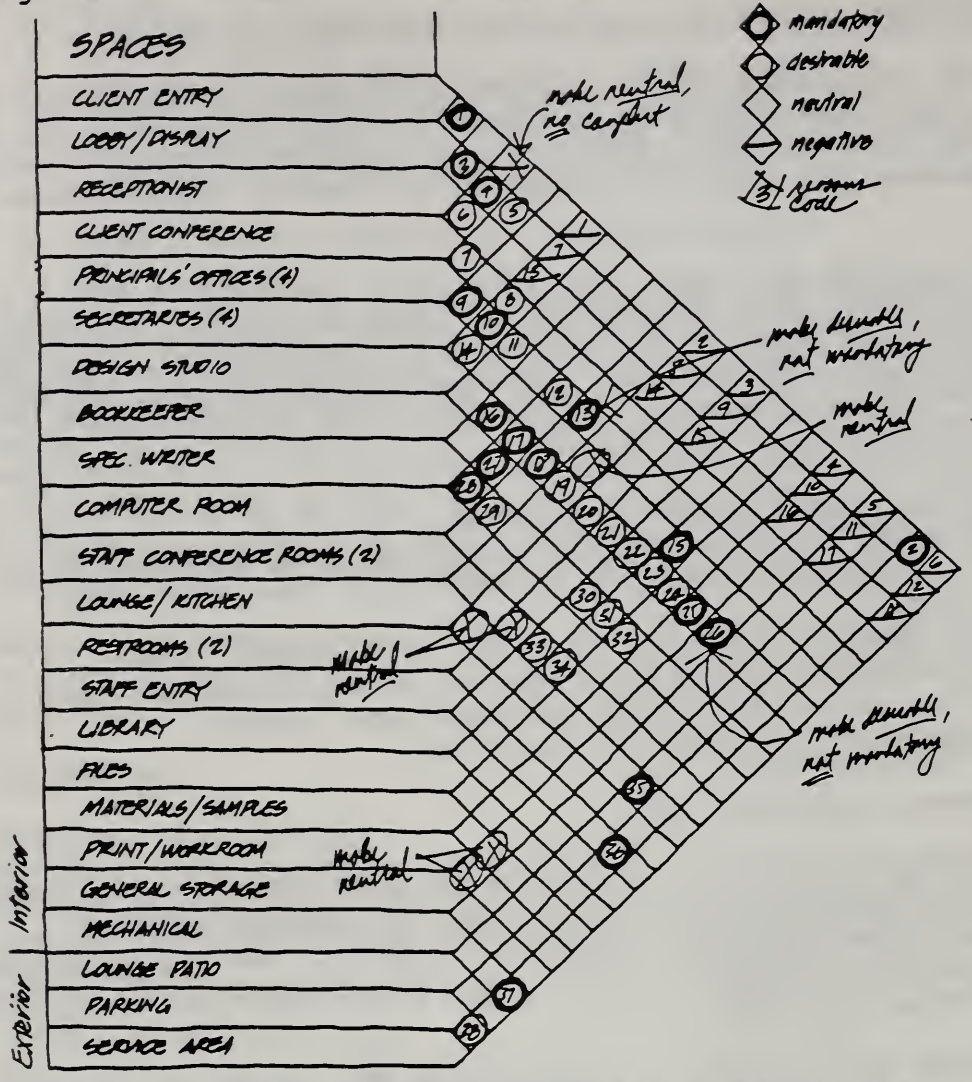
1. Extensive face to face contacts
2. Shared paper and/or electronic files and materials
3. Shared technology such as printers or FAX machines
4. Paper flow
5. Jointly used facilities such as conference rooms
6. Clarify whether functions should be enclosed or open
7. Decisions about furniture systems and layout
8. Help identify circulation patterns

6.4 Adjacency analysis (27)

Space adjacency analysis includes an understanding of work flow, circulation, proximity of functionally related spaces, ergonomics, furnishings, equipment layout, facility management and maintenance, movement patterns, supervision and control and organizational culture.

Matrices can be employed to determine the relative importance of the proximity of spaces and/or activities to enhance organizational performance.

Figure 6.1 Example of space matrix



Dimensions associated with adjacencies can be:

x. critical
xx. desirable
xxx. unimportant
xxxx. undesirable (should be separated)
Decisions about the matrix are made in conjunction with members of the using organization.

Analysis can be performed at any level: e.g.

Functional components

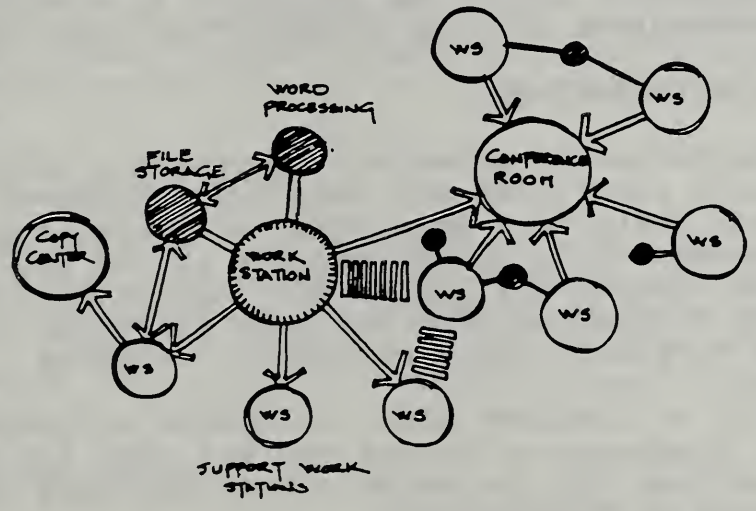
	1	2	3	4	5
1. Work stations		x	xx	x	xxx
2. Copying centers			x	xxx	xx
3. Word processing				x	xx
4. Conference					xxx
5. File storage (organizational unit)					

Work station

	1	2	3	4	5
Reading					
Writing					
VDT work					
Telephone usage					
Drafting					
Filing					
Meeting					

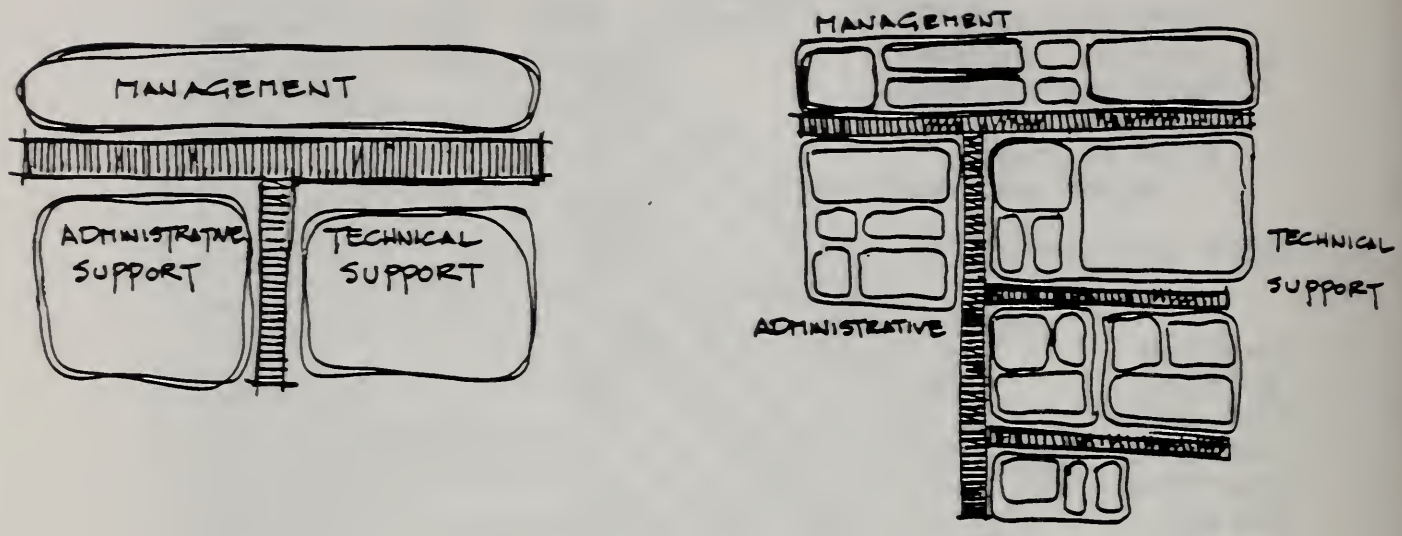
Bubble diagrams are a convenient method of converting decisions made in the matrix into functional spaces. An illustration of a bubble diagram is presented in Figure 5.2.

Figure 6.2 Example of bubble diagrams



Zoning diagrams can be used to group functional spaces by a variety of criteria that importantly influence building performance, e.g. into spaces that are quiet and noisy; public and private.

Figure 6.3 Example of zoning diagram



6.5 Building shell

The physical layout of the office is changing to accommodate the new mix of people and electronic technology. In determining spatial requirements for work stations and offices, constraints associated with building design must be taken into account. For example, office and work station layouts must be consistent with column sizes and placement, windows, and core utilities. Furniture selection should be sensitive to standard modules; i.e. the basic dimensions used in planning and construction.

6.6 Materials/finishings.

The characteristics of materials importantly affect many organizational activities and facility management operations. The absorbant and reflective properties of finishings and materials play an important role in the quality of the acoustic and visual environments. Sounds and lights can readily be transmitted from their origin to distant work stations and other areas, in the presence of hard and highly reflective surfaces.

The selection of finishes also influences maintenance costs and operations. Frequency of change and the need for flexibility also have implications for the selection of the type and variety of materials used in "finishings".

6.7 Architectural and furnishings relationships

Decisions about furnishings should be influenced by major building features. Clevinger posed a series of questions

concerning the relationship of furniture characteristics and building architecture (28).

6.7.1 Checklist of architectural and furnishings relationships (28)

1. How will the sizes of furniture relate to the architectural module?
2. Will the furniture coordinate with architecture?
3. Will bay spacing affect furniture size? How?
4. Does core location affect types of furniture specified?
5. Does floor-to-ceiling height constrain furniture size, panel heights?
6. How will availability of window space affect space planning?
   - Selection of panel height.
   - Transparency of panels
   - Orientation of work station
   - Proximity to work station
   - Field of view to window; e.g. aisles
7. Is selected flooring appropriate for types of furniture specified? Are combinations acceptable?
   - Resilient flooring with systems furniture
   - Low quality carpeting with expensive furniture
   - Plush carpets with systems furniture that will be rearranged often
   - Will chair casters be appropriate for flooring?
8. Can casters leave rubber marks on the furniture?
9. Will casters slow down movement on wood and resilient floors?
10. How will floor maintenance affect furniture over time?
11. How will wall choices affect furniture choices?
12. Can shelving be attached to demountable walls? fixed walls?

6.8 Special purpose spaces

As we noted earlier, decisions about work station configurations are intertwined with those of the general context of the office environment. Activities can be performed in a variety of locations, shared or individual. The decisions made as to how office design contributes to effectiveness varies from organization to organization.

6.8.1 Smoking spaces

New technologies and the desire for high quality environments have increased the variety of special purpose spaces found in many offices. Activities not associated with traditional offices are now becoming quite popular. Another contributing factor is the change in values among workers. For example, smoking is now prohibited in many areas of public buildings. People who smoke are now being accommodated in areas and facilities separated from non-smokers. This has important implications for the design of

HVAC systems responsive to different requirements for air quality.

6.8.2 Conference rooms

Open office planning has created problems for managers and professionals who require confidentiality and privacy to do their work. Many supervisors find themselves unable to perform administrative tasks without being concerned that they are overheard. Panel systems often contribute to this problem because they provide the illusion that a barrier exists around the work station, since visual privacy is accomplished. However, speech sounds can be readily heard over and through many panel systems (29).

The lack of confidentiality and privacy at individual work stations has increased the demand for small conference rooms. Typical conference rooms are often too large to meet the need for private conversations among supervisors and staff personnel. These rooms are also useful in promoting staff interactions, which is often disruptive in an open plan setting.

With the rapid upgrading of technologies, training rooms are becoming more widespread because of a continuing need to upgrade personal skills and transmit information to staff members.

6.8.3 Centralized duplicating facilities

Copying rooms are prevalent today. New and sophisticated systems provide the capability to produce documents with the quality formerly available only from printers. The cost of such systems can only be justified by organization-wide use. These systems are usually quite noisy and should be acoustically isolated from the general work floor. Merging of computerized printing, image processing, and duplicating facilities is a recent development.

6.8.4 Centralized communications and information processing

More offices are likely to contain large scale computers and systems such as telex and facsimile reproduction. Such equipment requires specialized spaces and facilities for occasional users.

6.8.5 Consolidated information storage

For the foreseeable future, paper will continue to be an important media for storing information. Large amounts of paper cannot readily be accommodated at individual work stations. Computer printouts and software manuals are being added to the storage requirements of office workers. In addition, microfiche, magnetic tape and disks must be stored. The latter two types of storage require careful environmental control.

6.8.6 Equipment areas

As more technology is moved into the office, more spare parts, cables, replacement systems and facilities for maintenance and checking are all needed. The demand for these resources will accelerate as office activities depend more on automation since equipment outages being very costly to productivity.

6.8.7 Furnishing storage space

With the popularity of open-office design, the increased acceptance of ergonomically responsive furnishings (tailored to individual needs), and the need to respond rapidly to change, there is a substantial need to maintain an inventory of furniture, panels, etc.

6.8.8 Equipment staging areas

As new equipment is added to offices, there is a need for a location to assemble and test units and systems before placing them on the work floor.

6.8.9 Magnetic media storage

Careful environmental control is required to ensure that information is preserved. Warping and stretching occurs in hot environments. Low humidity can cause problems due to static buildup, allowing dust and dirt to accumulate. Variable environmental conditions can affect the longevity and reliability of media performance. Among other potential problems are:

1. Magnetic fields.
   - Media should be kept away from transformers or large motors that generate magnetic fields. (This might influence the placement of uninterrupted power systems and erase electronic data.)
2. Shock and vibration.
   - These conditions can cause disks to lose information.
3. Chemical solvents.
   - Volatile chemicals can degrade media, and should not be stored nearby. Health and air quality issues of office personnel should be addressed in their storage and use.

6.8.10 Training spaces

As a result of new technologies, organizational changes, and the desire of the workforce to upgrade its skills, training has become a major on-going organizational activity. Spaces are needed which are flexible enough to cope with changing office and audio-visual technologies while fostering learning.

6.8.11 Swing spaces

Areas are needed where people can work while their work stations are being moved or reconfigured, minimizing work disruption. The alternative of moving during weekends or evenings is often precluded by its expense.

6.8.12 Day care centers

As more working mothers are employed in offices, facilities are needed to tend young children.

6.8.13 Exercise rooms

With the increasing need for workers to remain at VDT's for long periods of time, facilities to enable employees to exercise are becoming more prevalent in the public and private sectors.

Chapter 7 Office furniture systems

The components of an office work station, or office furnishings, are the physical elements that comprise the immediate environment for workers. It is therefore not surprising that office furniture systems are extremely important contributors to the overall satisfaction or dissatisfaction of employees to their work settings and their ability to perform their jobs productively.

Conventional office equipment (e.g. typewriter, telephone) placed few demands or constraints on the user or the furnishings. In contrast, new automated technologies have imposed specific and varied dimensional and environmental demands on office furnishings. Today's office furniture systems must cope with a rapidly growing inventory of electronic equipment, activities, and problems, while accommodating traditional tasks and equipment. For this reason, the selection of appropriate furniture has become a critical component of the planning and design process for the automated office.

Surveys of office workers have consistently shown that physical and psychological problems are prevalent when conventional furnishings are used in automated offices (41). A misfit between equipment and task requirements can often result in degraded job performance. For example, extensive work at a VDT placed on a conventional office desk can create physical discomfort and fatigue because of the awkward positions of the arms, hands and shoulders, when typing (30).

Furnishings are not limited to functional effectiveness however, they also serve symbolic purposes. For the organization and the individual, they are used as tangible evidence of status. That is, the quality of furnishings are frequently an important means of differentiating levels in an organizational hierarchy.

As executives and managers become major users of automated equipment, and space usage is curtailed, furnishings become more important as status symbols. As Clevinger (28) notes:"..it may become necessary to have a completely new generation of graduated-status office automation furniture so executives, middle managers, professionals, and clerical workers can be distinguished from one another. This "tiering" of furniture has become so ingrained in our culture for other furnishings, it needs consideration in automated offices."

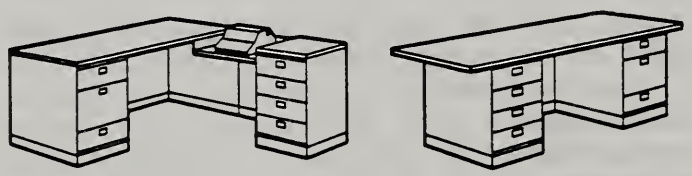
Office furnishings typically include work surfaces, storage, seating and display units. In open-plan offices, divider panels or screens play an important role.

Conventional furnishings - desks, filing cabinets, shelf units, chairs, display boards - constitute a collection of independent components used to accommodate traditional office equipment and activities.

Figure 7.1 Examples of conventional furniture:

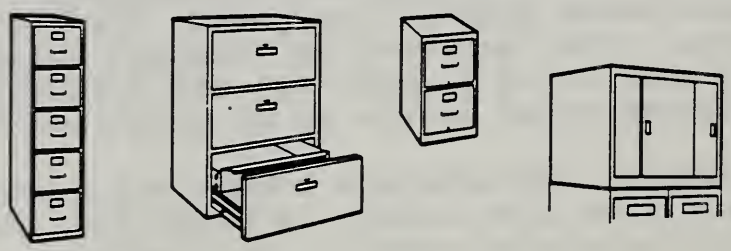
CHAIRS

WORK SURFACES

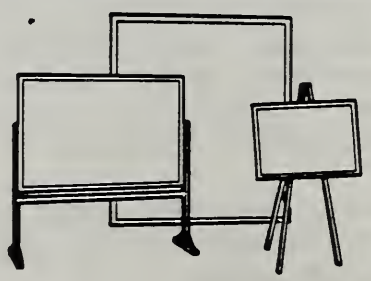


STORAGE

FILING



DISPLAY

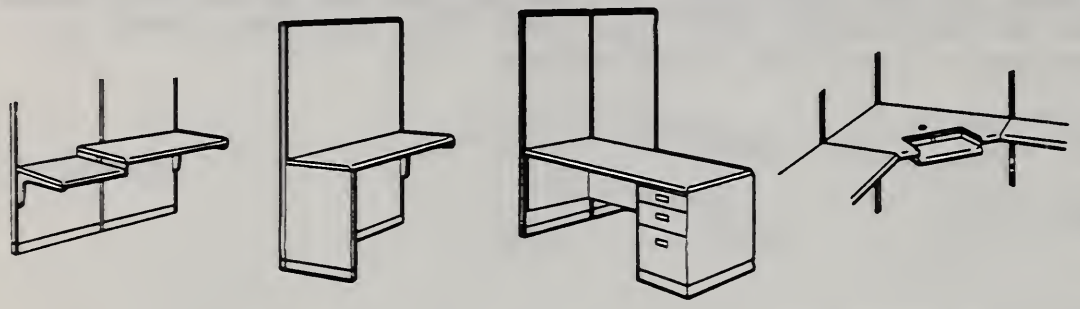


LIGHTING

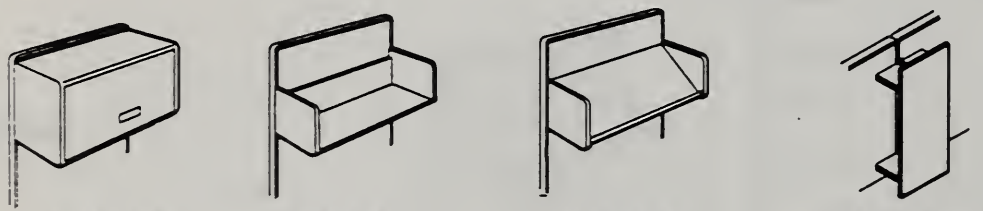
Systems furniture, in contrast, consists of interdependent modular components - work surfaces, filing, storage, shelf and display units - that often rely on load bearing panels for their support. Because these components are interconnected and interchangeable, the efficient use of both horizontal and vertical space can be increased. A primary intent of the systems furniture is to facilitate the need for work station moves and reconfigurations - i.e. its flexibility.

Figure 7.2 Examples of systems furniture:

Generally smaller scale
More adjustment features
Greater emphasis on ergonomic design
Broader chair lines, more options



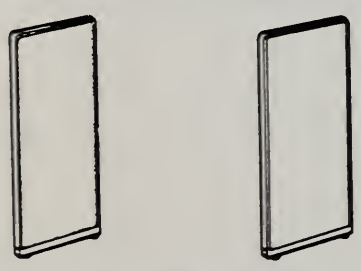
More diversified methods of work surface support
More variety in work surface shapes
More parts
Increased height adjustability
More options for wire management
Increased standardization of components
Increased hardware requirements
Greater interchangeability of parts



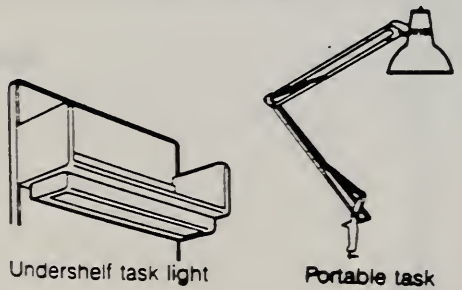
Enclosed shelf
Open shelf
Angled shelf
Wardrobe unit

Increased modularity of components
Greater interchangeability of parts
Better aesthetic integration
Greater utilization of vertical space
Increased hardware requirements

Greater utilization of lateral filing
Increased modularity of components
Better aesthetic integration



Better aesthetic integration
Greater interchangeability of functions



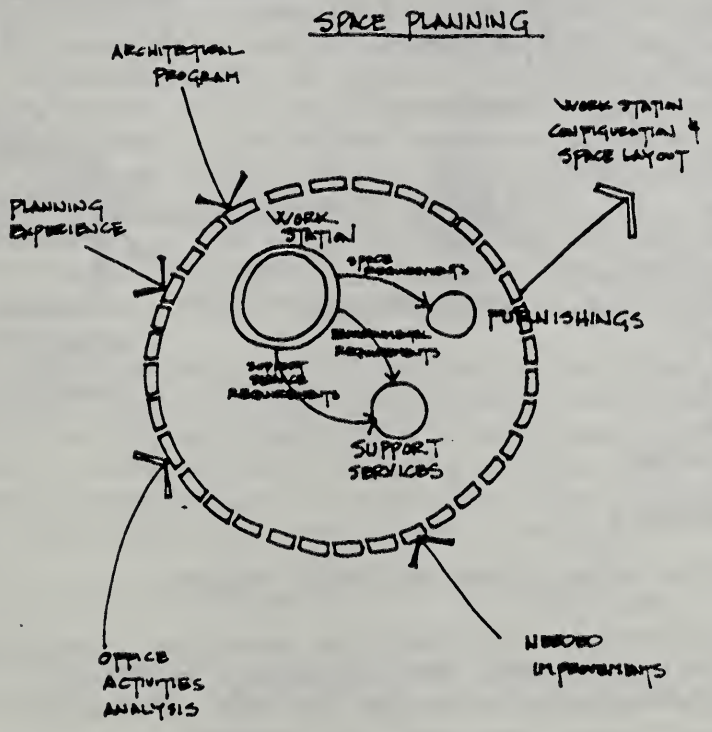
Undershelf task light
Portable task

Better aesthetic integration
More concentration of light on task

7.1 Furniture selection process

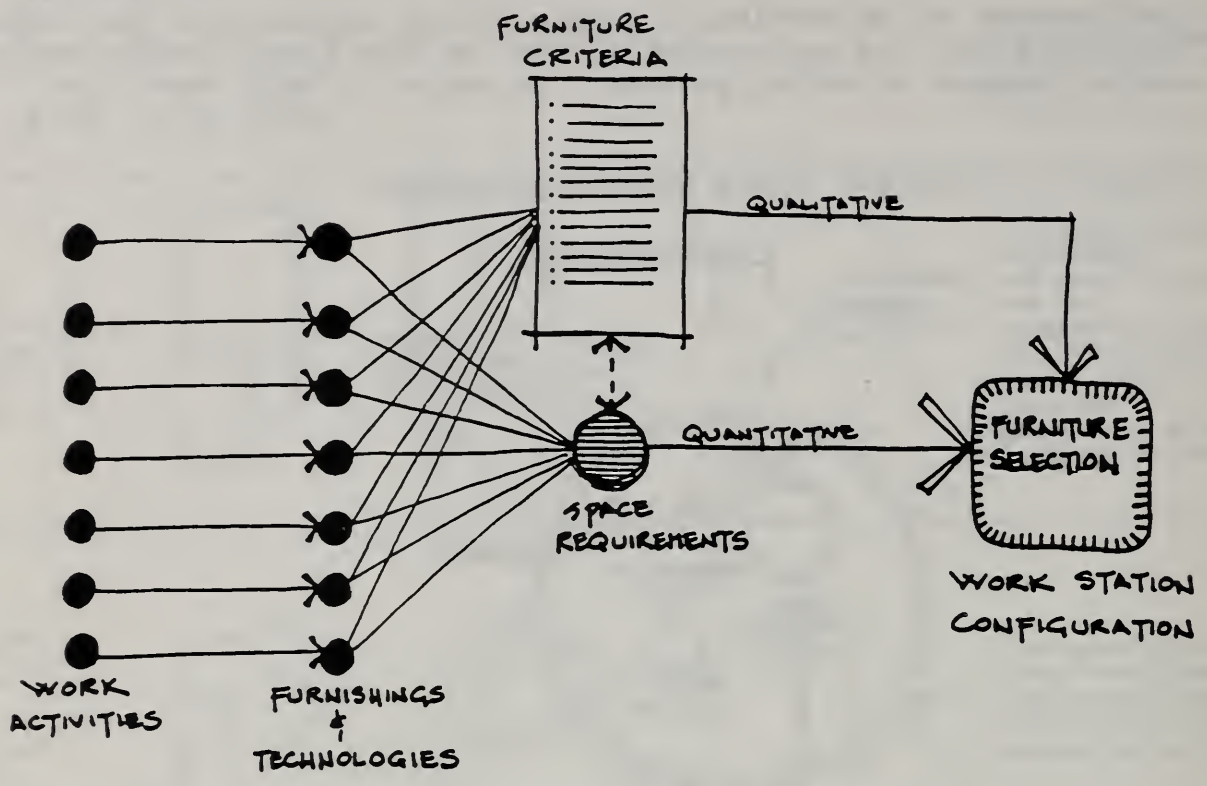
The process of selecting and specifying appropriate and adequate furniture for the automated office is the final component in the overall space planning process, as shown in figure 7.3.

Figure 7.3 Overall space planning process



This part of the process is designed to ensure that office furnishings provide an efficient interface between the user and the office equipment and the tasks to be performed. Failure to complete an activity analysis prior to furniture selection and configuration can result in a misfit between the furnishings and the workers job requirements, resulting in inefficient, uncomfortable and/or unproductive office operations. Because the overall evaluation requires a comprehensive understanding of user activities (manual and automated) and equipment capabilities, end-users, managers and designers should all be involved in this process. The last step in this process is to determine furnishing requirements to support the activities to be performed. The factors considered, starting with work activities and concluding with work station configuration, are depicted in figure 7.4.

Figure 7.4 Decision elements employed in making furniture selections.



Furniture selection comprises several steps:

1. Researching potential information sources - materials from vendors, evaluations of furniture systems.
2. Determining the appropriateness of the products.
3. Evaluating the "track record" of vendors.
4. Visiting offices with particular product lines, interviewing users concerning experience with products.
5. Most important of all - evaluating offerings in terms of carefully determined criteria.

7.2 Furniture criteria

The choice and specification of furnishings are critical to the performance and operational success of any facility. Systems furniture should enhance the work process and help carry it forward. Working height is of critical importance in furniture selection. If the height is too great, the shoulders and upper arms have to be raised, which can result in shoulder and neck pains or cramps. If the height is too low,, backaches may result. The correct table height should suit the dimensions of the body and the activity being performed.

It is important that office desks allow sufficient space for leg movement. The space for legs and feet should be at least 68 cm wide and 69 cm wide. To permit the person to stretch his or her legs, the distance from the table edge to the back wall at knee level should be at least 60 cm, and 80 cm at ground level.

The standard criteria used to evaluate quality and appropriateness of furnishings include, but are not limited to the following:

1. Function - applies to the way furniture will be used in performing activities and accommodating office machines and equipment.
2. Adaptability - concerns: a) moveability or the capacity to disassemble and assemble with minimal down-time; b) adjustability or the ability to modify features or components, e.g. height, flexibility.
3. Maintenance - includes construction stability, abrasion resistance, soil-hiding properties, resistance to stains, burns and chemicals.
4. Durability - is a matter of construction, design and materials. Furnishings should be engineered and designed around the requirements and constraints of the tasks and equipment.
5. Comfort/anthropometric considerations - refers to suitability for the individual and the prevention of physical or psychological problems with extended use.
6. Cost - covers both initial budget and long-term expenses.
7. Visual/aesthetic - refers to the general appearance of the furnishings, its attractiveness.

7.3 Evaluative schemes for furnishings.

Answers to the following questions can assist in the selection of appropriate and adequate systems furnishings (28).

7.3.1 Matching furniture and equipment needs

1. What furniture is needed to accommodate office machines and equipment? storage requirements? display?
2. What are the dimensions of the equipment? what does the equipment weigh?
3. Will special sizes of worksurface tables be needed?
4. What clearance is needed between equipment and hanging shelves?
5. Will the furniture support the equipment weight?
6. Can the furniture be configured for optimal work activity?
7. Can the furniture, chairs and equipment be adjusted to provide appropriate ergonomic support?
8. Will equipment keyboards be attached or detachable?
9. Can furniture accommodate printers? maintain stability when printer is in operation?
10. Will a sound hood be necessary?
11. Will the volume of storage cabinets be sufficient to hold computer media?

12. Are cabinets separated from heat and magnetic fields that could damage media? Can they withstand fire/water damage?
13. Will anti-static fabric be necessary for furniture?

14. Will anti-static carpeting be required?
15. Are any special surfaces needed for sorting/collating? for specific equipment, i.e. telephone tray?
16. Does furniture provide for security, e.g. locks?
17. Will furniture accommodate cabling to power source?

7.3.2 Flexibility Requirements

Among the questions to be asked are:

1. Are furnishings capable of change with minimum disruption to staff or activities? Is the hardware adaptable? Can the system be shifted, moved on a carpeted floor?
2. Do adjustments require special skills or tools?
3. Are systems simple and made of standardized components?
4. Are dimensions and heights of work surfaces adjustable to accommodate a range of activity and individual requirements and differences, i.e. left-handed person?
5. Will the component configurations accommodate changing requirements? Is the product standardized; available if additional components are needed?
6. Is the seating adjustable with firm back and neck support? Can the chair be raised and lowered?

7.3.3 Environmental Context

Among the questions to be asked are:

1. Does furniture adapt to the building module or ceiling grid?
2. Does the system optimize the use of vertical space?
3. Do acoustical panels work properly?
4. Does the furniture system control, modify, and conceal electrical and communications systems?
5. Are visual privacy needs satisfied?
6. Can the worker control the mini-environment?
7. Is the product durable, safe, and easy to maintain?
8. Do components relate visually to one another and the other system elements?
9. Is a "family" of products available, e.g., different but compatible colors?

7.4 Problems with furniture systems

7.4.1 User problems

A lack of detailed information about functions results in a misfit between system components provided and job requirements. The symptoms of this mismatch are many - some have physical

manifestations, while others have psychological ramifications for the user.

Some physical problems may be a nuisance and a hindrance to successful job performance, whereas others may actually create a harmful or dangerous work environment. For example, too little file storage or drawer space in a work station may be annoying and unproductive for the user, but improper lighting on a primary worksurface can create eyestrain for the user and inhibit productivity. Extension cords and tangled cables (from power source to equipment) may create unsafe conditions in a work station for both the user and the equipment. Lack of space for material storage at the work station often results papers placed in cardboard cartons. These cartons are unsightly and can constitute tripping hazards at the work station and/or the blocking of aisles.

There are means of overcoming objections to user problems with systems' furnishings. Knowledge of the tasks to be performed coupled with a sensitivity to user's individual needs are essential. The following questions should be considered during the furniture selection process:

1. Do the furnishings allow for an appropriate expression of individuality? of status?
2. Does the system provide a balance of privacy (both acoustical and visual) and accessibility for the user?
3. Will it encourage productivity by enhancing organization and communication?
4. Will the atmosphere be conducive to serious problem-solving tasks?
5. Can physical changes be made by the user, i.e. rearranging of partitions or storage compartments?

7.4.2 Problems with integrating different furniture systems

Special problems can arise when different furniture systems are used in an office. These can occur when relying on a single manufacturer or on several different ones. (31)

Among the issues that merit attention are:

1. Furniture dimensions differ
2. Configurations differ
3. Shell configurations are system unique
4. Connections differ
5. Uniformity of parts differ
6. Parts are seldom interchangeable

7.5 System Panels

System panels are a vital element in open-office design. The panels define the volume of the work station and serve as a boundary for the furnishings. Together the panels and

furnishings are called systems furniture. The panels provide acoustical and visual privacy, clarify office layout and facilitate wire system distribution. They are also used to "hang" systems furnishings, such as work surfaces, storage and display units.

The task of selecting a panel system can be complicated as it is frequently difficult for the untrained eye to discern the physical differences between different vendors' systems. It is also difficult to compare systems because of the multitude of parts and conflicting specifications from various vendors. While the furniture systems of many vendors are similar, none are identical and rarely are their parts or components interchangeable. When comparing various vendors' furniture systems (either specifications, drawings or actual layouts) the following should be taken into consideration:

7.5.1 Dimensions.

The dimensions of each furniture system tend to differ from every other system and the dimensioning methods tend to be different. For example, panels vary in width from 18 inches to 60 inches. While wider panels may require fewer connections, structural stability may be a problem. Panel heights range from 30 inches to 96 inches (80 inches is generally the highest panel). Lower partition heights produce improved communication and air circulation, but at the expense of privacy- both visual and acoustical. Higher partitions may create difficulties for HVAC and lighting systems.

Some manufacturers only provide a few different height panels, whereas others provide a broader range. Some of the taller panels (80" and over) can accommodate optional doors (an aid to enhance visual and acoustical privacy). In addition, some products weigh more than similar products, making them more difficult to move. For example, one vendors' standard fabric panel weighs 88 pounds while a similarly sized panel from another vendor weighs only 52 pounds.

7.5.2 Construction.

Panels are constructed with metal or wood frames, with or without exposed or integrated supporting posts. Connector systems vary widely but panel material composition is fairly standardized. Non-acoustical panels are often made of hardboard or honeycomb cores sandwiched between layers of laminate, wood veneer or metal.

The panels' exterior and interior construction must be evaluated in terms of durability and structural integrity. Exterior finishes can be rated based on their degree of maintainability and ease of renewability, i.e. can the panel be refinished or re-upholstered? Can this be accomplished without demounting-mounting the panel? Panel construction should be evaluated for its

strength, as well as balance, i.e. can it support the anticipated load(s)?

7.5.3 Panel colors and trim.

The colors and trim offered varies from vendor to vendor, with little coordination among vendors. There is little standardization of color or hardware systems. The trim serves both a functional and aesthetic purpose in the panel system. Functionally, it should be durable and connect cleanly to the panel.

7.5.4 Types of panels.

Panels range from free-standing, non-load-bearing partitions to power-distribution panels, which can be fully loaded. Rectangular panels can have openings - both with and without glass - or can be fully glazed. There are also curved panels, which allow good space utilization in tight spaces. Not all manufacturers handle a full line of panel types and it is therefore essential to know if different panel types can be fitted together (even if they are from the same vendor).

7.5.5 Acoustical panels.

Acoustical panels may have a hardboard core with layers of fiberglass or other sound absorbant material on both sides, covered by a layer of acoustically transparent fabric. Because many acoustical panels depend on honeycombed material to absorb sound, they tend to be less strong than non-acoustical panels. Where both structural integrity and a relatively high level of acoustical privacy are required, there are two options to consider: a panel with one side treated with a standard surface and acoustical materials on the other; or a structurally strong acoustical panel.

7.5.6 Fire-ratings.

Panels are rated according to their fire resistant features. As a minimum requirement they should comply with local codes.

7.5.7 Panel components and connectors.

Work station furniture - work surfaces, storage and display- generally attaches to panels. The construction of these components should be evaluated to ensure that their weight capacities are sufficient and that they operate satisfactorily, i.e. drawers should glide easily. The methods used to hang or support these components should also be carefully tested to ensure they are safe and secure. Some manufacturers require several different connector types for different furniture configurations, while others rely on a "standard" connector regardless of the panel configuration or type. Generally, the fewer pieces required to connect one panel to another (or a

component to a panel) the simpler both installation and reconfiguration will be.

7.5.8 Flexibility.

Consideration must be given to the ability to move and reconfigure the system. How many people will it take? Do the panels have leveling devices? Can they be moved over carpeted surfaces? If the panels have adjustable glides, will they fall out when the panels are moved or rearranged? If the panels have feet, do they stick out and constitute a safety hazard? Has consideration been given to the storage of spare connectors, components, and panels?

Some furniture systems have limited functional capabilities since they were designed to accommodate a limited number of layouts, whereas others offer more variety. Can a particular systems be configured as intended? Can it be added onto or changed?

7.5.9 Wiring

There are a number of advantages to using systems' furniture to extend the delivery and distribution of electrical and data/telecommunications from the building to the equipment. Flexibility is a key advantage because the furniture systems may be rearranged or reconfigured without disrupting the building system. Safety and reliability are enhanced because wires and cables are kept out of the way. Aesthetics are also improved when dangling and tangled wires and cables are out of sight.

Most furniture systems today offer some form of wire management. For wiring it is important to know the systems' capacity for both telecommunications and electric raceways. Some key questions about wiring are:

1. Are dedicated lines possible?
2. How many outlets can function off of one feed kit?
3. Will any outlet allow connection to any circuit?
4. Is wiring possible on straight, corner and x connections?
5. Is the wiring for the system UL-listed?

7.5.9.1 Panel Wiring

The system panel plays an important role with respect to electrical distribution systems in the open-planned office. It can be a very flexible and effective connection to and extension of the building distribution system. In effect, the system panel can act as an interface between the buildings' power distribution system (power, lighting and data/telecommunication) and the business machines, electronic equipment and lights for a work station or cluster of work stations.

(See Chapter 10, Wiring, for more detailed treatment of this subject)

7.5.10 Selecting Panel Components

When choosing panel components the following questions should be addressed:

1. Are components adjustable to fit individual differences in height, size, and work habits?
2. Can the product be used in right and left handed configurations?
3. Is the hardware adaptable?
4. Can components be moved, shifted on a carpeted floor?
5. Are angular configurations possible?
6. Is there optimum use of vertical space?
7. Do acoustical panels perform as desired?
8. Can electrical and communication systems be controlled, modified and concealed?
9. Do they adequately serve visual privacy needs?
10. Are the products durable, safe, and easy to maintain?
11. Are the products standardized; available if added components are needed?
12. Is there a family of products; e.g. compatible colors, textures?
13. Are there sound or light leaks between connected panels?
14. Are there slotted rails along the face edged to hang storage and work space components?
15. Is there provision for a coat rack?

7.6 Chairs

One of the most important furniture items influencing the performance of the office worker is the chair, especially for those spending most of the day at the VDT.

Chairs should have the following features (23):

1. Appropriate for traditional and VDT based activities
2. Enable a person to sit upright or tilted backward
3. A backrest with an adjustable inclination, and the capability to lock the backrest at desirable inclinations.
4. Backrest height of between 48-52 cm above the seat surface; width of between 32-36 cm
5. The upper part of the backrest slightly concave
6. A backrest with a lumbar pad
7. Foot rests for shorter people, to avoid dangling of feet
8. Adjustable chair height (38-54 cm), swivel, rounded front edge of seat surface, castors, 5-arm base and easily used controls

Part 4 Design Context Issues

Chapter 8 Lighting systems

Proper lighting depends upon the activities performed, the people doing the work, and organizational requirements. It must take into account traditional building elements such as ceiling heights, wall and floor materials and treatments, room area, adjacent spaces, columns and various equipment and systems. The integration of lighting with other systems, and flexibility are of special importance in the automated office. Uniform lighting levels for the most visually demanding task are no longer an acceptable approach to lighting design. Instead, an alternative approach today is task ambient lighting, with a combination of ceiling fixtures and individually controlled work station lighting.

VDT use in offices has increased the importance of lighting because most lighting systems were traditionally designed for desktop paper-based activities, with different visual requirements than those required by VDT tasks. For the foreseeable future most work stations will have to accommodate a combination of both types of activities.

While the primary purpose of lighting is to facilitate work, it also provides directional and locational information and is an integral component of security and safety systems. Furthermore, it can create an environment with variety, visual interest and pleasing contrasts, offsetting the institutional appearance of some offices.

The distribution of luminances of large surfaces in the visual environment is important. In general, the greater the contrasts, the more likely that problems of visual comfort and visibility will occur. Among the factors that will influence visual acceptability are the size of the glare source, its distance from a viewer's line of sight, and the intensity of ambient room illumination (23).

8.1 Lighting problems

Research studies have been consistent in their findings that lighting is a major problem in most automated offices. The light generated by the VDT, the task area adjacent to the screen, the keyboard area and the surround lighting is also important. Visual problems can occur when the eye must continually adjust to markedly different lighting characteristics, and the variety of contrasts associated with an activity such as reading paper copy while monitoring a VDT screen.

Office environments are generally designed under the assumption that the worker will perform tasks requiring the line-of-sight to be depressed approximately 20-40 degrees from the horizontal. The design of many VDT's requires line-of-site to be at or near horizontal. This elevation brings the operator's fixation point

closer to ceiling luminaires, resulting in a greater possibility of discomfort glare. Exposure to large luminance differences between the VDT screen and some other part of the visual surround, such as a window or luminaire, increases the possibility of discomfort glare. Glare reflected from VDT surfaces, windows, and ceiling luminaires make it difficult to read VDT displays by reducing the contrast between the characters and the screen background. Figures 8.1 and 8.2 illustrate glare situations in the office.

Figure 8.1 Problems of Direct and Reflected Glare

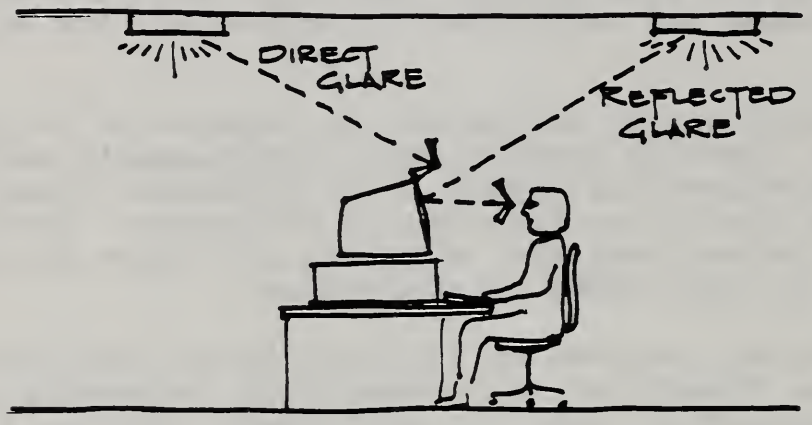
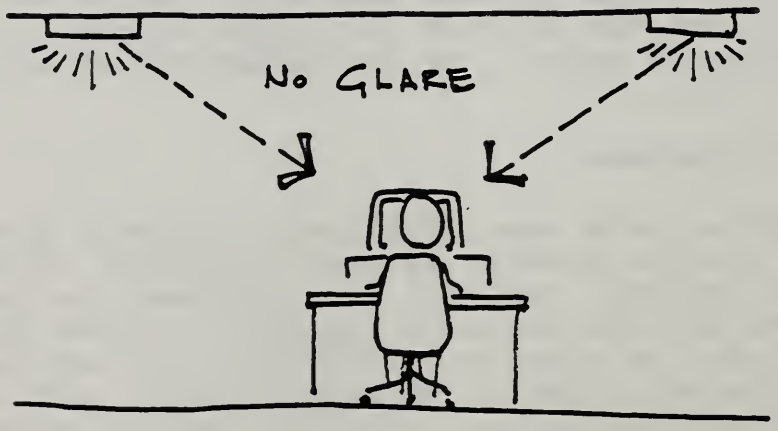


Figure 8.2 Positioning of work station to avoid glare



8.1.1 Specific lighting problem areas

1. Lighting systems at work stations must accommodate VDT and paper-based tasks
2. The line-of-sight of the VDT screen is near the horizontal, resulting in a greater likelihood of glare from a fixture in direct view.
3. Reflected glare can occur from reflections on the surface of the VDT, from windows, fixtures, people, and other VDT's.
4. Extreme visual contrasts in the visual field, created from VDT, the work space, general surrounds, windows, etc causes visual discomfort.
5. The placement of fixtures may be inappropriate for the tasks being performed by producing shadows, glare and reflections.
6. Indirect HID lighting can produce "hot spots" on the ceiling; they also might cause surface finish problems such as color distortions.
7. Color rendition of HID sources can result in aesthetic problems, especially when materials and furnishings are not carefully selected with regard to color characteristics.
8. Color stability and uniformity are sometimes a problem with HID sources.
9. Highly reflective materials can be sources of reflected glare.
10. Black and white "colors" can contribute to undesirable visual contrasts in the work setting.
11. Dirt and dust on fixtures and lamps can substantially reduce light output; scheduled maintenance is important.
12. Fluorescent task lamps and HID lamps can emit electronic noise, affecting devices nearby.

8.2 Lighting criteria

The proper design of work station lighting covers a variety of issues. Among the criteria used to ensure proper illumination are:

1. Lighting should reinforce the architectural intent of the building and provide a connection with the outside and between spaces; create a sense of intimacy and delineate activity spaces.
2. The quality and quantity of lighting should support the visual needs of those performing VDT and/or paper-based tasks.
3. Levels should be consistent with the tasks performed
4. Lighting should not produce glare.
5. Extreme brightness contrasts should be avoided.
6. Individual control of task and area lighting should be available.
7. Systems should provide flexibility appropriate for organizational needs, including expansion.
8. Systems should not be wasteful of energy.

9. Systems should be properly integrated with other building systems - e.g. ceiling, wiring, automation, safety.
10. Lighting should provide proper margins for safety and security activities.
11. Systems should be designed for ready maintenance.
12. Daylight should be appropriately integrated into the overall lighting system design.
13. Two lighting level systems should be considered for flexibility.

The following general rules are widely accepted (23):

1. All large objects and major surfaces in the visual environment should, if possible, be equally bright.
2. Surfaces in the middle of the visual field should not have a brightness contrast ratio of more than 3:1.
3. Contrasts between the central and peripheral areas of the visual field should not exceed 10:1.
4. The working area should be brighter in the middle and darker in the surrounding field.
5. Excessive contrasts are more troublesome at the sides than at the top of the visual field.
6. Light sources should not contrast with their background by more than 20:1.
7. The maximum brightness contrast within the entire room should not exceed 40:1.

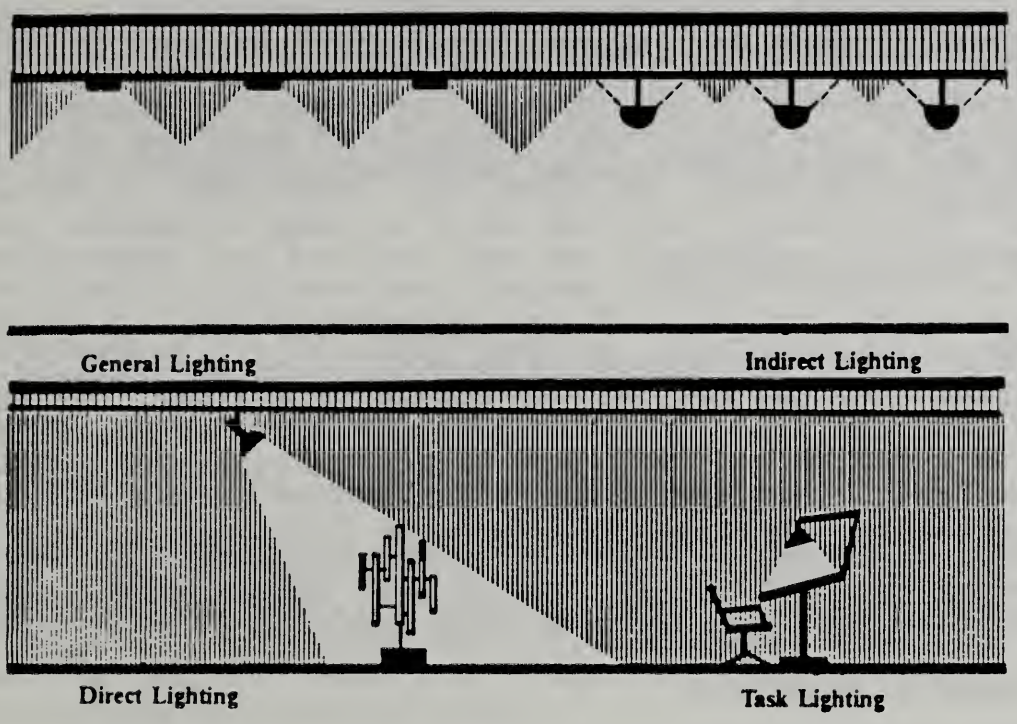
The choices of color and material is of critical importance for a balanced luminance distribution. Reflectances for an office with VDT's should be lower than those for a traditional office. A primary reason for this is to minimize the risk of reflectances from ceilings, walls and windows. The following reflectances are proposed by Grandjean (23):

1. Ceilings	70%
2. Windows, blinds or curtains	50%
3. Walls behind VDT screen	40-50%
4. Walls opposite VDT screen	30-40%
5. Flooring	20-40%

8.3 Lighting design approaches

Four general approaches are available for office lighting- general (ambient), task, task/ambient, and indirect. Ambient lighting refers to a uniform pattern of lighting throughout a space. This approach is supplanted in many offices by task/ambient systems provide a relatively low light level for movement and circulation purposes (i.e. less demanding visual tasks), and direct lighting on the task to be performed. Direct lighting has the advantage of efficiently using the available light to accomplish a given purpose, but glare and veiling reflections must be avoided. Indirect lighting uses wall and/or ceiling surfaces to reflect light into the work space for ambient lighting and architectural definition.

Figure 8.5 Illustration of lighting schemes



8.3.1 Ambient (General) lighting

An ambient system provides uniform illumination across the entire space, at the level required to support the most visually demanding visual task to be performed in the office. The location of particular tasks does not have to be specified because the assumption is that if the lighting level is appropriate for the most demanding task, then it will be sufficient for less difficult ones. The connected power requirements are a function of the overall lighting level and the size of the area served. Ambient lighting can be provided by direct (usually part of the building system) or indirect means. Ceiling fluorescent systems are usually employed for ambient lighting.

8.3.2 Task lighting

Lighting is directed to a specific surface or area to provide illumination for visual tasks. Typically, light sources are placed on top of a desk, hung from a panel, place above a work surface,or under an overhead bookcase.

8.3.3 Task/Ambient lighting

In task/ambient systems, task lighting is treated separately from the general surround (ambient), which is usually at a lower level. Task location must be known in advance to ensure the

adequate space planning density, and the particular needs of work stations where different tasks are performed. Power use is variable because lighting is typically controlled by the user. The overall space will appear non-uniform because of the lack of a standardized lighting scheme. Task lighting systems can be furniture mounted, free standing, or depend on suspended luminaires. The major requirement is to meet the needs of individual users with diverse performance, habits, and visual abilities.

8.3.4 Indirect lighting

Another method employed to illuminate VDT work is indirect lighting. Here, the source is mounted below the ceiling, suspended from the ceiling, or placed in a kiosk. In all instances, the light must be directed toward the ceiling, which acts as a reflector. Rays are directed laterally, resulting in shadow-free lighting with the light source hidden from view, and eliminated as a possible irritant. As long as hot spots are avoided, this type of lighting can be successful in VDT environments. Wall washing can be used to increase general interest in the space by providing patterns of brightness.

8.4 Lighting controls

Lighting controls allow the occupant to adjust the lighting to suit the activity to be performed. They also serve an important energy-saving function. Local lighting controls can activate a small number of fixtures which permit the lights to be readily turned off when not needed. Dimmers also provide the opportunity to adjust the lighting conditions as visual requirements change.

A variety of automated control systems are available; they frequently are dependent on a combination of manual and automated features. For example, time switches are employed in areas not often used. In some configurations, lighting is activated manually and automatically deactivated after a given time, unless manual intervention occurs. Some centralized lighting controls send signals to fixtures over existing circuitry; others use radio frequencies or require new wiring.

Controls are available which work on the principles of motion detection (ultrasonics), body heat (passive infra-red), noise in the human activity range (acoustics), or the interruption of beams transmitted and detected (active infra-red). Carbon dioxide is also used as an occupant sensor. (Some of these systems are also used for building security purposes.)

Window lighting should be controlled by curtains and blinds which also filter and direct sunlight at reasonable cost. Vertical blinds can be turned and pivoted to redirect sunlight. A fabric finish is preferable because it diffuses the light, reducing glare. Mylar and plastic filters and screens can be positioned in front of windows like sunshades.

8.5 Maintenance

Lamps should be replaced before failure because light output declines with use. Replacing lamps early therefore maintains a greater average light output for the entire system. Relamping before failure also lengthens ballast life. Group relamping is best accomplished by changing all lamps at the same time. When personnel, equipment, and lamps are assembled simultaneously, a lamp change is made in a few minutes. In contrast, single lamp replacement can take as long as 30 minutes. A further savings is realized if fixtures are cleaned during scheduled relamping. A periodic cleaning schedule for fixtures and lamps is a requirement, if designed lighting levels are to be maintained over the lifetime of the building. Dust and dirt accumulations can severely limit the efficiency of lighting systems (6).

8.6 Environmental context

When a person is operating a VDT, he or she looks not only at the work materials, but peripherally at the work surface, distant furniture and walls, windows and the general office area. Sharp contrasts in color and reflective surfaces should be avoided because they may result in visual distractions and/or difficulty in performing required tasks.

The characteristics of the surrounding environment must therefore be carefully controlled to ensure the visual comfort of VDT operators. Walls and other surfaces should have reflectance values of less than 50 percent to provide a lower brightness contrast between the room surfaces and the VDT. All desk and work surfaces should be comprised of matte, or low glare non-reflective surfaces, and medium tone colors. They should not be black or white, or exhibit sharp color contrasts or reflective surfaces, to minimize visual irritation. Carpeting colors should be muted rather than saturated in color. Neutral color tones are preferred for all furnishings.

VDT's should be positioned so they are not parallel to each other. This avoids the possibility of light from screens reflecting on one other. A test to ensure that the major problems have been eliminated is to move a mirror across the front surface of the VDT screen. If a bright light source can be seen in the mirror while in the normal seated position, the source is likely to cause reflected glare on the screen.

8.6.1 Lighting and furnishings

1. Will furniture colors, fabrics and finishes be selected to absorb or reflect light?
2. How will finishes, materials and colors affect glare and contrast?

3. Is furniture integrated lighting specified? What task lighting is specified?
4. How will panel heights affect light dispersion?
5. Can furniture be oriented and placed to take best advantage of ceiling lights?

8.7 VDT screen glare - proposed solutions

A major complaint by VDT operators has been screen reading difficulty due to glare.

The most effective preventive measure to minimize glare problems is the adequate positioning of the screen with respect to lights, windows and other bright surfaces. If the light source is behind the operator, it can easily be reflected onto the screen. If the source is in front of the worker, the result is direct glare.

In VDT offices, lighting fixtures should provide primarily a downward distribution of light, with built-in louvers, parabolic mirrors or prismatic pattern shields. The luminous flux angle should not exceed 45 degrees.

Lighting control can take several forms:

1. Control of lighting fixture, optics
2. Sunlight control
3. Control of colors, fabrics, finishes, furniture
4. Screen treatments

Three general types of approaches are employed to deal with this problem. One is to "treat" the VDT itself, another is to control the lighting on the task, a third is to deal with design features.

Parabolic fixtures are an example of a glare control mechanism found to be helpful in VDT environments. The primary function of the parabolic form is to minimize the brightness of the light fixture as viewed from normal working positions. Often called a low brightness fixture, the specularly reflective surfaces, along with the parabolic shape, is designed to direct the light downward without allowing light to scatter at high incident angles. Since most of the light is directed downward and not outward, the fixture appears as a fairly dark source from the typical viewing position, and thus, tends not be a glare source. Louvers are often added to control light along the opposite axis.

Figure 8.6 illustrates a parabolic system.

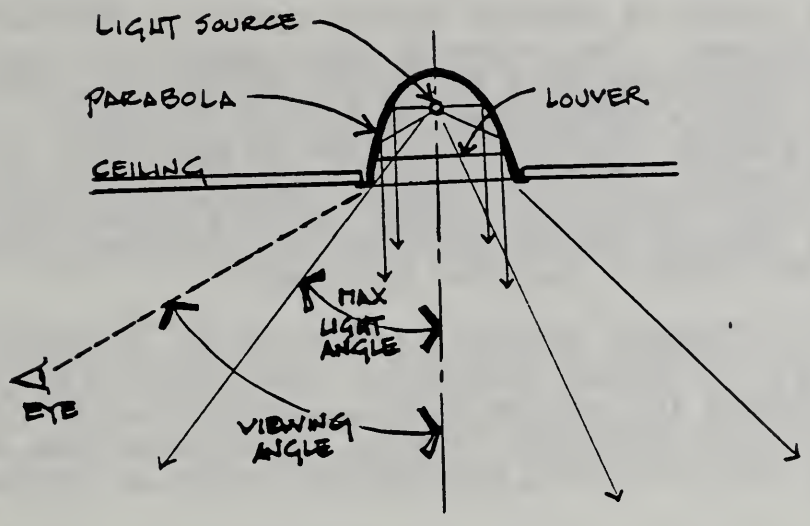


Figure 8.6 Parabolic lighting

Another way of avoiding glare problems to orient the occupant and the VDT as shown in figure 8.2. The sources of light are perpendicular to the viewing direction; consequently, the sources are not directly in the normal field of view, nor is light reflected into the occupant's eyes as work is viewed on the screen.

8.8 Checklist for glare control

Direct and reflected glare should be limited by means of one or more of the following methods:

1. Screen hoods may be installed.
2. Anti-glare filters may be installed on the VDT screen.
3. Direct lighting fixtures may need to be recessed; and baffles used to cover fluorescent fixtures to prevent the luminaires from acting as a glare source.
4. Use special covers on light fixtures to direct light downward rather than allowing it to diffuse.
5. Properly installed indirect lighting systems will limit the luminaires' potential as glare sources.
6. Drapes, shades, and/or blinds over windows should be closed or directionally adjusted, especially during sunlight conditions.
7. Position terminals properly with respect to windows and lighting fixtures, e.g. screens facing away from bright sources.
8. Indirect lighting fixtures should have appropriate lens/louver systems to minimize glare potential.
9. Avoid specular surfaces on furnishings and equipment.

Chapter 9 Acoustics

The auditory needs of workers depend upon the characteristics of the work performed. For example, many managerial and professional functions have stringent acoustical demands and are performed by people accustomed to a quiet workplace. Professionals spend considerable time in planning, creative thinking and report writing. These activities are susceptible to distraction from noise intrusions. On the other hand, many office tasks require office machines and systems inherently noisy, such as copiers and most printers.

With respect to speech privacy, confidential discussions play an important role in office activities. The general public is often served by private and public organizations in open-office environments. The subjects of many discussions are highly personal and confidential, and should not be in danger of compromise.

The acoustical properties of spaces are influenced by the thickness and density of enclosing structures, the porosity of wall and floor covers, insulation, drapes and furnishings. Sound is also affected by room shape, volume, and the characteristics of furnishings.

9.1 Noise problems

Noise and the lack of acoustical privacy are two of the major problems identified in surveys of office workers, especially those in open space designs.

The predominant noise effects in offices are interference with speech communication, distraction from activities, and annoyance. The degree of annoyance due to noise experienced by an individual depends on a variety of factors:

1. The noise level
2. Its nature; unexpected and irregular noise is especially disturbing, as is high frequency noise.
3. The activity being performed; intellectual work is more susceptible to disruption than routine tasks.
4. Ones' attitude toward the noise source; noise produced by the individual as part of an activity is less disturbing than noise produced by others.
5. Information content; speech sounds are especially disruptive.

While noise in traditional offices constituted a problem, in electronic offices using open plan systems, the difficulties are compounded. Many office surveys have demonstrated that noise is the major source of complaint in high technology offices (32). Distractions are caused by people, activities, and equipment. Conversational noises, telephones ringing and the sounds of keyboards, disk drives and printers all contribute to a disruptive setting which impedes office work. Noise control is

needed at the work station, the operating unit and the work floor as a whole.

Personal equipment such as dot matrix printers should be provided with acoustical covers and acoustically designed surrounds. Floor, ceiling, and wall surfaces and window controls should be selected to diminish sound reflection within spaces and transmission between spaces. An important criterion for the selection of an office device should be its sound output; the best means of controlling noise is minimizing the sound source.

Another problem is lack of effective noise isolation from noise producing equipment. Unlike the situation in a private office where such noises are largely confined to a specific work area, in the open-office design these noises frequently intrude to many work areas where individuals require a quiet environment to engage in analytical activities.

9.1.1 New Acoustic problems - automated office design responses

The solutions employed to cope with several of the design problems posed by office automation have important implications for acoustical design. For example:

1. Expanded utility chases are placed above a lowered ceiling or beneath a raised floor. Chases provide excellent noise passages, and flanking paths for conversations meant to be private.
2. Supplementary air conditioning units placed above lowered ceilings can introduce undesirable noise sources into the office.
3. Elevated lightweight floors provide excellent sound and vibration radiating diaphragms (i.e. sounding boards) for equipment, machinery and footstep noises.
4. The mechanization of office tasks results in a proliferation of noisy equipment such as copiers and printers.
5. Open-office planning exposes the office work force to more noise.
6. Automation of activities has exposed noise sensitive tasks such as planning to noise intrusions.
7. Placement of localized air conditioning units to dissipate heat load of new equipment produce considerable noise.
8. Operation of office machines in open environment when privacy is essential.
9. Telephone rings not readily identified with particular phones.
10. Partition walls provide visual barrier with little realization that people can be overheard.

The nature of the activities performed will greatly influence the acoustic requirements at an individual work station. As more office employees engage in knowledge work requiring considerable concentration, freedom from noise disturbances is likely to assume greater importance to workers.

9.2 Acoustic criteria

A proper acoustical environment consists of:

1. Adequate acoustical privacy; consistent with the activity performed.
2. Freedom from intrusive noise sources.
3. Freedom from distracting vibrations.
4. Ability to conduct conversations at normal speech levels.
5. Isolation of major noise sources from general working environment.
6. Special acoustical treatment for sensitive activities/spaces, e.g. conference, audio-visual rooms.
7. Control of telephone rings; ensure that ring of one phone is identified and not confused with nearby telephones.

9.3. Auditory privacy

Two kinds of privacy have been identified. Normal privacy- a condition where speech from adjacent locations can be understood if one listened intently, but is not loud enough to cause a disturbance. Confidential privacy precludes the understanding of phrases and/or sentences in adjoining locations.

9.4 Typical solution approaches

There are ways to control sound in an office and ways to measure the effectiveness of that control. One method of control is the creation of a barrier to reduce or eliminate noise by reflecting or resisting its transmission. Another is the use of sound absorbing material.

9.4.1 Barriers

Another important method of dealing with sound is to block or eliminate noise by reflecting or resisting its transmission. The mass of the material used as a barrier determines its effectiveness, the greater the mass, the better the performance. Typical fixed barrier materials in buildings are sheet rock, gypsum board, concrete, brick or wood. Partitions used in open-offices are moveable barriers.

The performance of a wall, for example, is measured in decibels (dB). The measurement is referred to as the sound transmission loss (STL).

The extent to which sound is impeded is expressed as sound transmission class (STC), which is a mathematical rating of the panel throughout a frequency range. Good materials should be effective within the frequency range of 250 to 3000 hertz, where the ear is most sensitive to sounds. A rating of 0 indicates no drop in sound level from the material, while an STC of 50

indicates that almost all sound is blocked. A good office panel should have a rating of at least 23. (29)

9.4.2 Isolation of Surfaces

Isolating surfaces is a means of preventing vibration transmission from one space to an adjoining one. One method of achieving this is to place rubber, compressed fiberglass or springs between surfaces. The isolation of a surface receiving impact, such as a floor or ceiling, from the structure, will restrict the transmission of sound.

9.4.3 Sound Absorption

The surface treatment of a space is the single most important determinant of its acoustical properties. Sound is absorbed by using porous materials to dissipate or absorb acoustical energy, e.g. fiberglass, cloth. The sound absorption coefficient is a measure of the sound absorbed by a surface; hard materials such as concrete and steel have low values, while carpeting has a relatively high value. The degree to which sound is absorbed is expressed as a number - between one and zero. This is called the material's noise reduction coefficient (NRC). The NRC is the arithmetic average of the absorbtivity of the material at several sound frequencies. An NRC of 1 means that all sound is absorbed. For acoustical privacy, an NRC should be at least .80. (29).

Materials used to absorb sound have a low mass, and therefore are not effective in preventing sound transmission to adjoining spaces.

9.4.4 Vibration Damping

Vibration damping is used to prevent a material or object from resonating to a primary source, thereby acting as a secondary noise source, e.g. an air conditioning unit mounted in a window frame. Windows, walls, and machine components are potential problem areas. Rubber or vinyl is typically laminated to the surface of the noise producing element to avoid this problem.

9.4.5 Isolation of Noise Source

An effective means of controlling unwanted sound is to isolate and/or "sound treat" the source of noise. For example, duplicating and printing equipment should be located remote from activities requiring quiet. The room should be acoustically treated if noise-sensitive activities are nearby.

9.4.6 Organizational methods of controlling noise:

9.4.6.1. Telephone rings

Telephone answering systems and protocols should be tailored for the activities performed. For an organization heavily dependent

on the telephone for communication, a phone ringing is a major distraction for several reasons:

1. It is difficult to localize and therefore a person cannot determine which organizational unit the call is for.
2. Rings are usually uniform, therefore adjacent units are distracted and uncertain as to whether it is for them.
3. Procedures often call for others to answer the phone after a pre-determined number of rings. In a telephone intensive operation, this can result in "bedlam".

Several methods are available for minimizing telephone ring problems:

1. Lower the sound levels of the rings.
2. Substitute light signals for the telephone ring, after a limited number of rings.
3. Provide distinctive tones (rings) for telephones within defined areas. This would eliminate some confusion as to the phone to be answered.

9.4.6.2 Activity groupings

Individuals and working groups should be clustered (or separated) based on their needs for quiet, and their requirement to interact with one another.

In placing furniture, one should take into account the direction faced by the individual when speaking to others in person or over a telephone. Layouts that reduce the number of times that a person talks while directly facing a person in a nearby work station can provide a substantially higher level of acoustical privacy (29).

9.5 Design and noise control

Floor, ceiling and wall surfaces and window controls should be selected to lessen sound reflection within spaces and between spaces. Transmission paths should be identified and care taken that sound insulation material is used where needed.

Ceilings which reflect sound are apt to be the major acoustical problem in an open office. If a high percentage of the ceiling is devoted to light fixtures, major reflection problems can be encountered if proper criteria are not used in their selection. Parabolic light fixtures can significantly reduce sound reflections, often a problem with acrylic lensed light fixtures, which offer a reflective surface for sound.

Carpeting provides an efficient means of eliminating impact sounds on floors caused by people, equipment and furniture movement. They also have very desirable sound absorption properties.

9.5.1 Work station furnishings

Panels and screens can be used to cut off horizontal paths of sound, while providing a degree of acoustic and visual privacy to individuals and/or working groups. Among the acoustic issues to be explored with regard to furnishings area:

1. How will printer noise be controlled?
   - Acoustical hood
   - Acoustical panels
2. How will cooling fan noise be controlled?
3. Will acoustical ratings of specific panels be needed?
4. How will the orientation of work stations/offices affect acoustics?
5. Does reflected sound from furniture components pose a problem?
   - Transparent panels
   - Acoustical panels
   - Cabinets
   - Desks/work surfaces

9.5.2 Masking Sound

Background noise is frequently used in open-space designs as a means of securing speech privacy. This "white noise" is generally introduced by means of ceiling speakers. This approach is not recommended because unwanted sound (noise) is not an optimum design solution. The noise associated with HVAC systems can frequently accomplish the same purpose, without introducing new noise sources.

9.6 Checklist - acoustical design

9.6.1 Noise Control

1. The outer shell of the building should provide adequate protection from outdoor noise sources; control of fenestration is particularly important.
2. HVAC and plumbing equipment should be selected, installed and operated to minimize noise; ancillary equipment should not be noisy.
3. Automated equipment should be as quiet as feasible; vibration isolation from floor and furnishings should be considered.
4. Sound absorption properties of ceilings, floors, and panels are a major design concern.

9.6.2 Acoustical privacy

1. Spaces for confidential meetings should be available in open offices.
2. Adequate separation is required between work stations to ensure proper acoustical comfort.
3. Partitions should be selected and placed in accordance with noise reduction needs.
4. Flanking paths should be avoided between private spaces and

the general workfloor; special attention should be given to lowered ceilings, raised floors, and utility chases.
5. Consider using natural sound from HVAC to substitute for masking noise.

9.6.3 Vibration control

1. Plumbing, HVAC and other mechanical equipment should be vibration isolated.
2. Noisy automation equipment should be vibration isolated.
3. Raised floors should be designed with high vibration damping features.
4. Emergency power generators should be located, installed and used to avoid vibration and noise problems.

9.6.4 Space Design

1. Individuals and working groups should be clustered in accordance with acoustical requirements, e.g. privacy, freedom from noise intrusions.
2. Noise producing equipment should be grouped and separated from general office activities when feasible.
3. Panels and screens should be used to intercept horizontal sound paths.
4. Ceilings with a high percentage of light fixture area can result in noise reflection problems.

Chapter 10 HVAC and control systems

As workers engage in a variety of activities at the work station, they need conditions to support different activities. This contrasts with the traditional office where the work was relatively fixed and environmental conditions could be engineered to be unchanging as well.

Many modern office buildings were designed to be energy conserving, with features that provided little flexibility to cope with the additional heat load generated by computers and other equipment. For example, large floor areas were often limited to a few large HVAC zones. The addition of technologies at work stations and elsewhere creates major problems in balancing HVAC systems appropriately, creating "hot spots" throughout the office.

"Engineers can calculate the capacity of an air conditioning system only when they know all of the facts. Information regarding move-in work station configurations, window access, panel and wall heights, ceiling heights, and the numbers of people and numbers and types of equipment within the space should be quantified as early as possible in design planning and programming. Changes during construction and decisions about furnishings can negate initial calculations, thereby causing problems with temperature control and air circulation" (33).

A recent study by the National Academy of Sciences summarized many of the key differences between traditional and high technology office buildings (3).

The study indicates that technological advances have led to a capability for versatile communication and computer systems used by building occupants as well as versatile automatic or semi-automatic control systems for supporting a more responsive internal environmental system. While the technologies are the same, building systems are run by the building engineer, while the operational systems are controlled by the user or operating unit.

Despite the separation of system responsibilities, the applications are interdependent. For example, computerized work stations make demands on the power distribution network and cooling systems. If occupants are to have the freedom to move work stations, the building support systems must have the flexibility to accommodate these changes. Energy monitoring and control systems should account for the temporal distribution of work activities and their variation in different parts of a building. That is, building systems should have the flexibility to support varieties of tasks at different building locations.

Localized control of environmental attributes such as air flow, temperature and window glare, is now feasible. Control technology

has produced digital electronic sensing and actuating devices which are cheaper and better than the pneumatic and electromechanical systems they replaced. When these capabilities are connected to networks and sensors, a highly responsive building environment is achievable.

Computerized work stations make special demands on HVAC and electrical distribution systems. When work stations are relocated, the HVAC and power systems should accommodate new equipment and different locations with minimal disruptions. Space to accommodate more wiring capacity is a critical determinant of successful design.

10.1 HVAC systems

HVAC systems are the means used to provide thermal comfort for building occupants. 'Thermal comfort' is a term used to describe a combination of air temperature, humidity and air movement conditions required for people occupying buildings.

Proper air quality and thermal comfort is often difficult to achieve, especially when technology is added piecemeal. The HVAC systems are often undersized and can't accommodate the new equipment. For example, air distribution intake and outlet vents are often blocked during major redesigns; ventilation rates are not responsive to increased density of equipment and people. Adequate cooling for equipment is required.

Adding technology to offices has increased cooling requirements in offices. For example, a VDT generates approximately the same heating load as a person. When added to an office in sufficient numbers, they add a load to the cooling system that sometimes exceeds its design capacity. When technology is not placed uniformly throughout a building, which is often the case, the balancing of the building HVAC system is a continuous problem. (Since change is the norm, whether equipment is added, or work stations rearranged, HVAC system balancing is an ongoing challenge.)

The air and thermal qualities of office spaces are affected by the type of furniture systems used. Surveys of offices have repeatedly demonstrated that air quality and thermal performance of offices have been adversely affected when technologies and systems work stations have been added to traditional offices (33). Among the problems identified are:

1. The inability of the original HVAC system to cope with the added heat load of added equipment.
2. Blocking of air vents by panel systems.
3. A misfit between HVAC zoning and furniture system configurations.
4. Inappropriate zoning to cope with modifications of furnishings and equipment.

For all control systems, choices must be made between building-wide, zone-wide, local control or a combination of them; among central/ programmed control or individual/local control.

The maximized localized control is represented by a private office with a thermostat that can be regulated to the satisfaction of the individual occupying the space. The popularity of open office designs has limited the numbers of people who have this degree of control of their environment.

One method of providing some localized HVAC control is a variable air volume (VAV) system. It provides localized control for each occupant depending on individual requirements and provide flexibility to accommodate space changes and organizational moves.

New systems are now available which provide air distribution through the floor, thereby permitting localized control to the work station (34).

Chapter 11 Wiring

Possibly the most important reason for focusing on activities performed at the work station in designing the automated office is the need to make appropriate wire management decisions. The foundation for improved office productivity is advances in information and telecommunications systems. These technologies are accessed by the individual by the "electronic nervous system", e.g. appropriate wiring systems. Moreover, as a result of frequent changes due to organizational and technological factors, work stations and associated systems are moved and/or modified at a rate estimated at 30% per year on the average (3). The flexibility of the wire management system is a key determinant in the ability to make such changes efficiently, at minimum cost, and with the least disruption to ongoing work.

Wiring systems in offices have undergone rapid changes in recent years. Manufacturers now offer new systems, designed to provide maximum flexibility. Their products have greater capacities and more security for communications wiring. The automated work station has accelerated the pace of improvements.

The electronic and control systems require networks of wires and cables, for electric power, voice, and data which are distributed throughout the building, and must be readily accessible. An important design principle is the ability to make as many changes as possible locally. For example, if new wiring is needed, it should only run from the work station to the closest wiring closet, not to the cable entrance. This can be accomplished by laying spare wire from the communication room to each wiring closet, or at least providing pathways (e.g. ducts, risers) to accommodate wiring when needed.

The greatest possible versatility in relocating equipment is provided by a distribution of both signal receptacles and power distribution modules throughout the building. This makes it possible to "plug in" computer terminals wherever desired. However, this flexibility is available only if the necessary wiring is initially planned. Since the computer typically requires clean power, and other electrical equipment does not, it may be economical to have "clean power" and "dirty power" outlets at each work station.

Once cables are brought vertically to a building floor, a variety of choices are available for work station distribution. The actual selection are dependent on the building's geometry and interior systems. Ultimately, the power, data, and voice cables must be usable at the work station.

It is important to know the cable type, size, and quantity for each piece of equipment, the bending tolerance of each cable and the equipment location within the work station. Other required information includes: the amount of cable storage needed, types

of work stations within clusters, and the density of clusters and equipment within work station and clusters. Finally the building interface points must be identified; usually one connection per cluster to link partition with the building's electrical distribution system.

The complex needs for wiring can be systematized within partitions, and plugged into building system when redesign is needed. Partitions must work with existing structural components.

11.1 Wiring problem areas

A number of problem areas associated with wire management have been identified in recent studies (3,6):

1. Cable management is often inadequate in even the best of electronic work stations, typically underestimating cable size, separation needed between power, data and voice cables, and cable turning radii, distribution and trunking.
2. Installing and operating many different types of cable makes it difficult to implement changes. It is not unusual for almost 50% of the terminals and telephones in place to be moved within one year.
3. Even with raised floor systems, moving work stations often poses major problems. The power is available but it is sometimes difficult to bring the power to where needed. If the hole or wiring is in the wrong place, a good deal of panel movement is needed.
4. There is a tendency to underestimate the number of outlets needed per work station, resulting in extension cords everywhere.
5. Even when there is sufficient power for vertical distribution, bringing power to work stations is sometimes difficult; adding conduits through a raised floor or overhead if needed. Access holes often have to be moved around.
6. In within furniture wiring, it is difficult, time consuming and expensive to pull wire.

11.2 Wiring criteria

11.2.1 General

1. Capacity. Sufficient physical space to accommodate cabling, connectors, and advanced equipment such as local area networks.
2. Convenience. Flexibility and ease of initial work station installation and future changes.
3. Cosmetics. The appearance at distribution and delivery points, and special treatment required.
4. Credibility. Code acceptance, single system responsibility, reputation of manufacturer.
5. Cost. Complete distribution and delivery cost; first cost to building shell, move-in; and ongoing costs (6).

10.2.2 Specific

1. Optimized flexibility is needed to accommodate future changes; tradeoffs must be made between frequency of changes, initial and long-term costs.
2. Wiring and communications systems should be integrated when feasible, e.g. information and energy management; proper shielding is also required.
3. Systems should be aesthetically acceptable.
4. Wiring changes should not disrupt ongoing activities.
5. Dedicated circuits should be used to maintain critical operations such as security, safety, and highly critical information services.
6. When laying cable, future needs for communications and office automation systems must be considered.
7. Complete wiring diagrams and records are needed, updated to reflect all changes automatically by CAD system if possible.
8. Cabling should be identified everywhere it enters or exits a room.

11.3 Checklist for wiring system design

1. With cellular flooring and underfloor ducts, system flexibility is governed by the spacing of electrical cells, but can be augmented by undercarpet systems.
2. Maintenance areas must be designed with sufficient space for distribution boxes and panels for changes and planned expansion.
3. Expansion space is needed in the building core to install additional bus risers for communications and power.
4. Extra sleeves are required for future power and communication cables.
5. Additional riser space might be needed on each floor for office automation systems and networking, including mainframe and minicomputer linkages.
6. Ceiling heights of rooms must accommodate raised floors; ceiling plenums must be deep enough to accommodate present and future needs.
7. Sufficient capacity is needed for feed conduit, vertical risers, telephone closets, and conduit to individual tenants.
8. Specific needs of building users should be considered, such as industry specified requirements for medical groups, stockbrokers.
9. Plenum space requires plenum rated cable approved by local fire regulation agency.
10. Electrical needs for telephone/wiring closets.

11.4 Wiring and furniture systems

Some of the latest innovations in wire distribution are those associated with furnishings. Some systems are an integral part of the furniture, others have raceways to accommodate wiring, and still others are separate. Activated partitions is a popular

method to connect building electrical and communication systems to work stations.

Clevinger developed a checklist for the integration of wiring and furniture (28):

11.4.1 Checklist for furniture wiring

1. Will furniture provide for proper management of cable and wire (vertical and horizontal) from the equipment to the power source?
2. How will excess cable be managed?
3. Will pin connectors and grounded plugs be accommodated?
4. Has the appropriate number of outlets been established at each work station?
5. How will clean power be distributed to work stations?
6. Has space been allocated for distribution of additional cabling?
7. Will furniture accommodate all wiring and future changes?
8. How does furniture manage normal and oversized plugs and connectors?
9. Are electrified panels specified; how will they be integrated into power distributions system?
10. Determine the best locations to join furniture and building wiring.
11. Identify the most appropriate distribution system for routing wires and cables thru partitions and/or furniture between building power distribution system and equipment.

11.4.2 Steelcase wire planning

Steelcase (34) suggests the following approach to wire management:

1. Know the best locations to join furniture system with building wire distribution system.
2. Determine most appropriate distribution system to route wires and cables through partitions and furniture and between the building's power distribution system and the equipment.
3. Plan for storage requirements for excess lengths of cable and wire.
4. Provide adequate work station outlets for electrical and telecommunications equipment.
5. With respect to the type and quantity of wiring needed, it is important to determine what equipment is used at each work station, how they are linked together as well as:

    a. How much bending each cable can tolerate?
    b. Where the equipment will be located within a work station?
    c. How much cable storage is required at each work station?
    d. Which work stations are connected in clusters?

e. The location of work station cluster connections with building's electrical distribution system.

11.5 System panels for wire distribution

The system panel plays an important role with respect to electrical distribution systems in the open-planned office. If the systems furniture (namely the panels) is to provide a flexible connection from the building to the equipment it must function as follows: as an interface with the building system; as a means of wire distribution; as wire storage; and as a point of access to electrical and data/telecommunication equipment.

11.5.1 Interface

The furniture system may be directly connected to the buildings' power system, either through a panel base (raceway) or via power poles. Wires and cables may be routed directly into a panel base from the floor or from the ceiling through power poles.

11.5.2 Wire Distribution

The furniture system - panels and components - should provide a means of distributing wires and cables from the building to each equipment location. Distribution may be horizontal or vertical, but there are three basic approaches used in wire distribution.

Three basic approaches are used in wire distribution.

1. Panel with a raceway that accommodates electrical wires and communication cables of all kinds, including coaxial, mixed media.
2. Panel which can be equipped with an optional manufacturer - supplied power pack, with panel-to-panel connectors, and hooks up to the building's electrical grid.
3. The prewired panel, already assembled and plugged into the electrical grid.

11.5.3 Storage

Systems furniture must provide safe and secure storage for wires and cables. For aesthetic reasons it is also desirable that wires and cables be kept out of sight. There are several effective storage methods such as the use of expanded raceways or hooks, spools or trays, that can be mounted under work surfaces.

11.5.4. Access

The systems' furniture should also provide cable access openings and adequate electrical outlets at various heights and positions. Care and consideration must be given so as not to block access points by freestanding furniture or objects.

11.5.5 Simple raceway with panel

This system is assembled before the panels and adds a few inches to the height of the total panel system. Among the specific issues to be considered are:

1. Are the wires and cables accessible?
2. Are the base plates and covers concealing the wires sufficiently durable?
3. Are separate channels available for communications and electrical wire?
4. Are the power feeds from the floor and ceiling available and accessible?
5. Are there optional convenience outlet strips?
6. How difficult is it to manage wire, make replacements and changes?

11.5.6 Power pack

Power availability is a major concern for all wiring systems. Among the factors to be considered are:

1. Is the wiring system retrofitted to non-electrified system panels?
2. Are there integrated convenience outlets at work surface height?
3. With systems having integrated ambient lighting, can lighting circuit be turned off while task and convenient lighting are active?
4. Are there pass-through panels for areas not requiring electrified outlets?
5. Are there sufficient outlets in each circuit?

12. Conclusions

The present report has described a design process that can be used for office work stations. The process assumes that effective work station design starts with a thorough understanding of the activities to be performed. Layout, furnishings and equipment support the end-user in his or her work. While the work station is the basic design unit dealt with, environmental and other design features strongly influence the ability to work effectively. These issues are also covered in the document. Checklists based on research and design experiences are included as an aid to designers, end-using organizations, and facility managers, faced with the responsibilities of designing effective office work stations.

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Appendix. Example of forms used for work station analysis: Case study 4

CASE STUDY #4

- PROFESSIONAL JOB:

ACTIVITY	HRS/DAY AT ACTIVITY
1. USING VDT	< 2 HRS/DAY
2. READING/WRITING	< 2 HRS/DAY
3. ANALYSIS OF MAT'L	< 2 HRS/DAY
4. PREPARE BRIEFING MAT'L	RARELY
5. ATTENDING MEETINGS	< 2 HRS/DAY
6. TALKING ON TELEPHONE	< 2 HRS/DAY

SPACE CHARACTERISTICS:

FLOOR AREA FOOTPRINT	- 48¢
DESK TOP AREA	- 32¢
LINEAR FEET STORAGE	- 14'

NORMAL OFFICE TASKS/ACTIVITIES	IMPORTANCE	LEVEL 0	LEVEL I: LOW USE	LEVEL II: MEDIUM USE	LEVEL III: HIGH USE
A. READING/WRITING		NEVER	RARELY	✓ < 2 HRS/DAY	> 2 HRS/DAY
B. ANALYZING		NEVER	RARELY	✓ < 2 HR/DAY	> 2 HRS/DAY
C. REVIEWING MATERIAL		NEVER	RARELY	< 2 HRS/DAY	> 2 HRS/DAY
D. FILING (HARD COPY MATERIAL)		NEVER	RARELY	< 2 HRS/DAY	> 2 HRS/DAY
E. COMMUNICATING VIA TELEPHONE		NEVER	RARELY	✓ < 2 HRS/DAY	> 2 HRS/DAY
F. MEETING W/ PEOPLE		NEVER	RARELY	✓ < 2 HRS/DAY	> 2 HRS/DAY
G. TYPING		NEVER	RARELY	< 2 HRS/DAY	> 2 HRS/DAY
H. ACCOUNTING/CALCULATING		NEVER	RARELY	< 2 HR/DAY	> 2 HRS/DAY
I. MANAGING/SUPERVISING		NEVER	RARELY	< 2 HRS/DAY	> 2 HRS/DAY
J. DRAFTING/DRAWING		NEVER	RARELY	< 2 HRS/DAY	> 2 HRS/DAY
K. USING VDT		NEVER	RARELY	✓ < 2 HRS/DAY	> 2 HRS/DAY
L. USING MICROFICHE		NEVER	RARELY	< 2 HRS/DAY	> 2 HRS/DAY

A. READING/WRITING

	ACTIVITY LEVEL			MINIMUM SPACE REQUIREMENTS			
	LEVEL I	LEVEL II	LEVEL III	FLOOR AREA (SQUARE FEET)	DESK TOP AREA (SQUARE FEET)	STORAGE (LINEAR FEET)	NOTES
1 – DESK TOP SPACE FOR PAPER	●	✓●	●		14.5		
2 – DRAWER STORAGE FOR MAT'LS	●	✓●	●			5.0	
3 – STORAGE FOR ACTIVE FILES			●				
4 – STORAGE FOR ARCHIVAL FILES		✓●	●			*	
5 – STORAGE FOR BOOKS		✓●	●			2.0	
6 – STORAGE FOR REFERENCE MAT'L			●				
NECESSARY W/IN WORK STATION:					14.5	7.0	
* NOT NECESSARILY W/IN WORK STATION:						*	
TOTALS:					14.5	7.0	

FOR THIS ACTIVITY:

MINIMUM DESK TOP AREA

MINIMUM STORAGE LINEAR FOOTAGE

B. ANALYZING

	ACTIVITY LEVEL			FLOOR AREA (SQUARE FEET)	DESK TOP AREA (SQUARE FEET)	STORAGE (LINEAR FEET)	NOTES
	LEVEL I	LEVEL II	LEVEL III				
1 - DESK TOP SPACE FOR PAPER	●	✓●	●		9.7		
2 - DESK TOP SPACE FOR CALCULATOR			●		1		
3 - STORAGE FOR ACTIVE FILES		✓●	●		2	3.0 2	
4 - STORAGE FOR ARCHIVAL FILES			●			*	
5 - STORAGE FOR BOOKS			●				
6 - STORAGE FOR REFERENCE MAT'L			●				
NECESSARY W/IN WORK STATION:					9.7	3.0	
*NOT NECESSARILY W/IN WORK STATION:						*	
TOTALS: FOR THIS ACTIVITY:					9.7	3.0	

MINIMUM DESK AREA

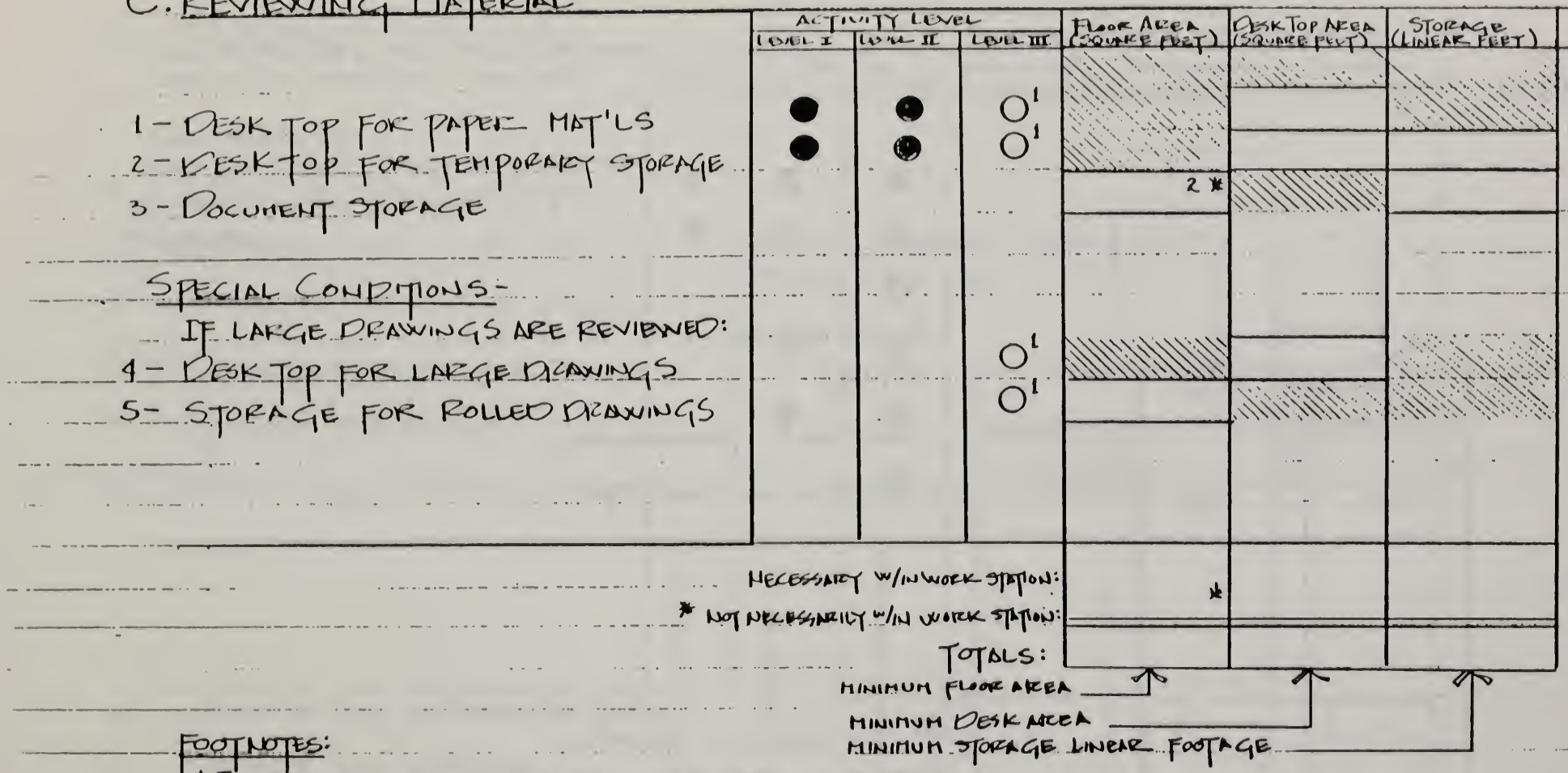
MINIMUM STORAGE LINEAR FOOTAGE

FOOTNOTES:

1 UNLESS CALCULATOR IS MAINTAINED ON DESK TOP DO NOT INCLUDE AS ADDITIONAL DESK TOP AREA.

2 STORAGE FOR LEVEL II AS LINEAR FEET; FOR LEVEL III AS ADDITIONAL DESK TOP AREA

C. REVIEWING MATERIAL

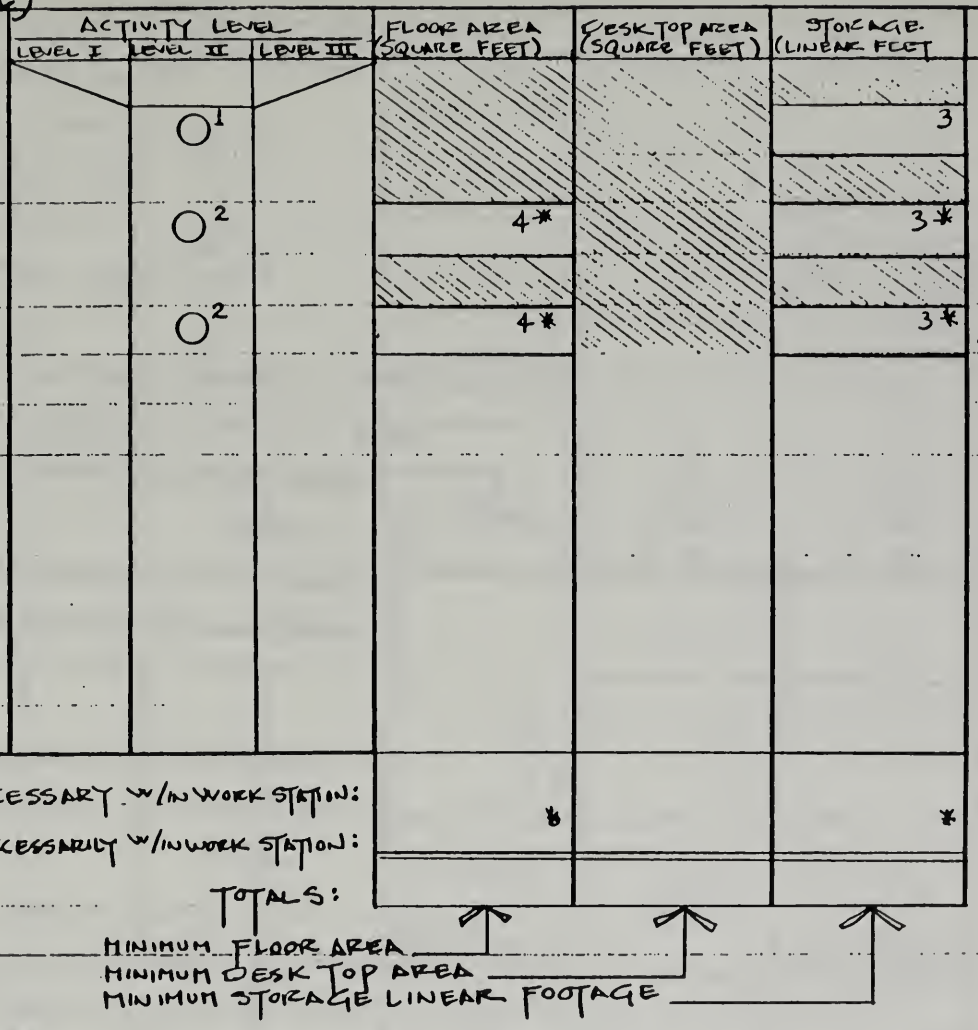


FOOTNOTES:

1 IF SPECIAL CONDITIONS APPLY, USE SPECIAL CONDITION SIZES IN LIEU OF NORMAL CONDITION SIZES.

2 ARCHIVAL STORAGE OF DUPLICATE REPORTS.

D. FILING (HARD COPY MATERIAL)



FOOTNOTES:

1 INCLUDE ONLY WHERE TASK IS PERFORMED AT WORK STATION.

2 INCLUDE ONLY IF TASK IS OCCUPANT HAS SOLE RESPONSIBILITY FOR FILES, OR IF NOT ACCOUNTED FOR IN EARLIER WORK STATION CALCULATIONS (WHERE FILES ARE SHARED).

3 ACCOUNT FOR LEGAL FILES WHERE NECESSARY.

4 FOOTPRINT OF FILE SYSTEM; SYSTEM ITSELF MAY BE ORIENTED VIRTICALLY.

E. COMMUNICATIONS VIA TELEPHONE

	ACTIVITY LEVEL			FLOOR AREA (SQUARE FEET)	DESK TOP AREA (SQUARE FEET)	STORAGE (LINEAR FEET)	NOTES
	LEVEL I	LEVEL II	LEVEL III				
1 – DESK TOP SPACE FOR TELEPONE		✓● [1]			1.0	1.0 [3]	
2 – DESK TOP SPACE FOR NOTE TAKING		○			1.0		
SPECIAL CONDITIONS – IF MODEM COMMUNICATIONS USED:							
3 – DESK TOP SPACE FOR MODEM		○			2*		
NECESSARILY W/IN WORK STATION:					2.0	1.0	
*NOT NECESSARILY W/IN WORK STATION:					*		
TOTALS:					2.0	1.0	

MINIMUM FLOOR AREA

MINIMUM DESK TOP AREA

MINIMUM STORAGE LINEAR FOOTAGE

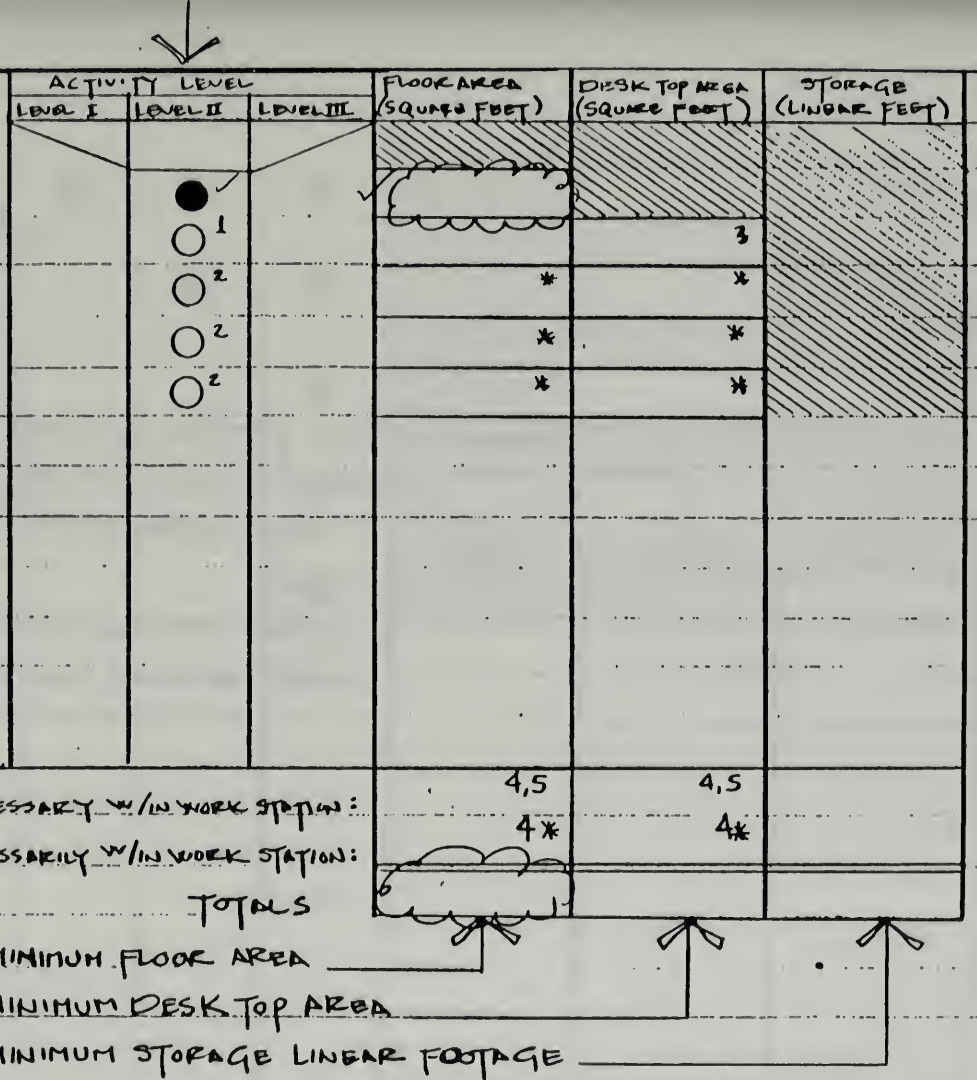
FOOTNOTES:

[1] FOR MANAGERS, PERSONNEL STAFF, AND SUPERVISORS CONVERSATIONAL PRIVACY MAY BE CRITICAL.

[2] TELEPHONE UNIT AND MODEM UNIT SPACE MAY BE IDENTICAL FOR SOME COMMUNICATION DEVICES.

[3] STORAGE FOR DIRECTORY INFORMATION – MAY BE STORED ON ELECTRIC MEDIA.

F. MEETING w/ PEOPLE



FOOTNOTES:

1 MANAGERS, PERSONNEL STAFF, AND SUPERVISORS MAY REQUIRE SECOND CHAIR.

2 THIRD & FOURTH CHAIR FOR USE WITH MEETING TABLE - FOR THOSE CONDUCTING INFORMAL TEAM MEETINGS, etc.

3 DESK TOP AREA FOR SHARED MATERIAL.

4 WHERE MEETING IS OF HIGHLY CONFIDENTIAL NATURE SEPARATE ENCLOSED (ACOUSTICALLY PRIVATE) SPACE SHALL BE CREATED

5 WHERE VISITOR IS NOT PART OF ORGANIZATIONAL UNIT, CONSIDERATION SHOULD BE MADE TO ACCESS AND APPEARANCE OF WORK STATION.

G. TYPING

	ACTIVITY LEVEL			FLOOR AREA (SQUARE FEET)	DESK TOP AREA (SQUARE FEET)	STORAGE (LINEAR FEET)	NOTES
	LEVEL I	LEVEL II	LEVEL III				
1 – DESK TOP SPACE FOR TYPEWRITER	●[1]	●	●		1 *		
2 – DESK TOP SPACE FOR DICATION DEVICE		○[2]	○[2]				
3 – STORAGE FOR FORMS		○[2]	○[2]				
NECESSARY W/IN WORK STATION:							
* NOT NECESSARILY W/IN WORK STATION:					1 *		
TOTALS:							

MINIMUM FLOOR AREA

MINIMUM DESK TOP AREA

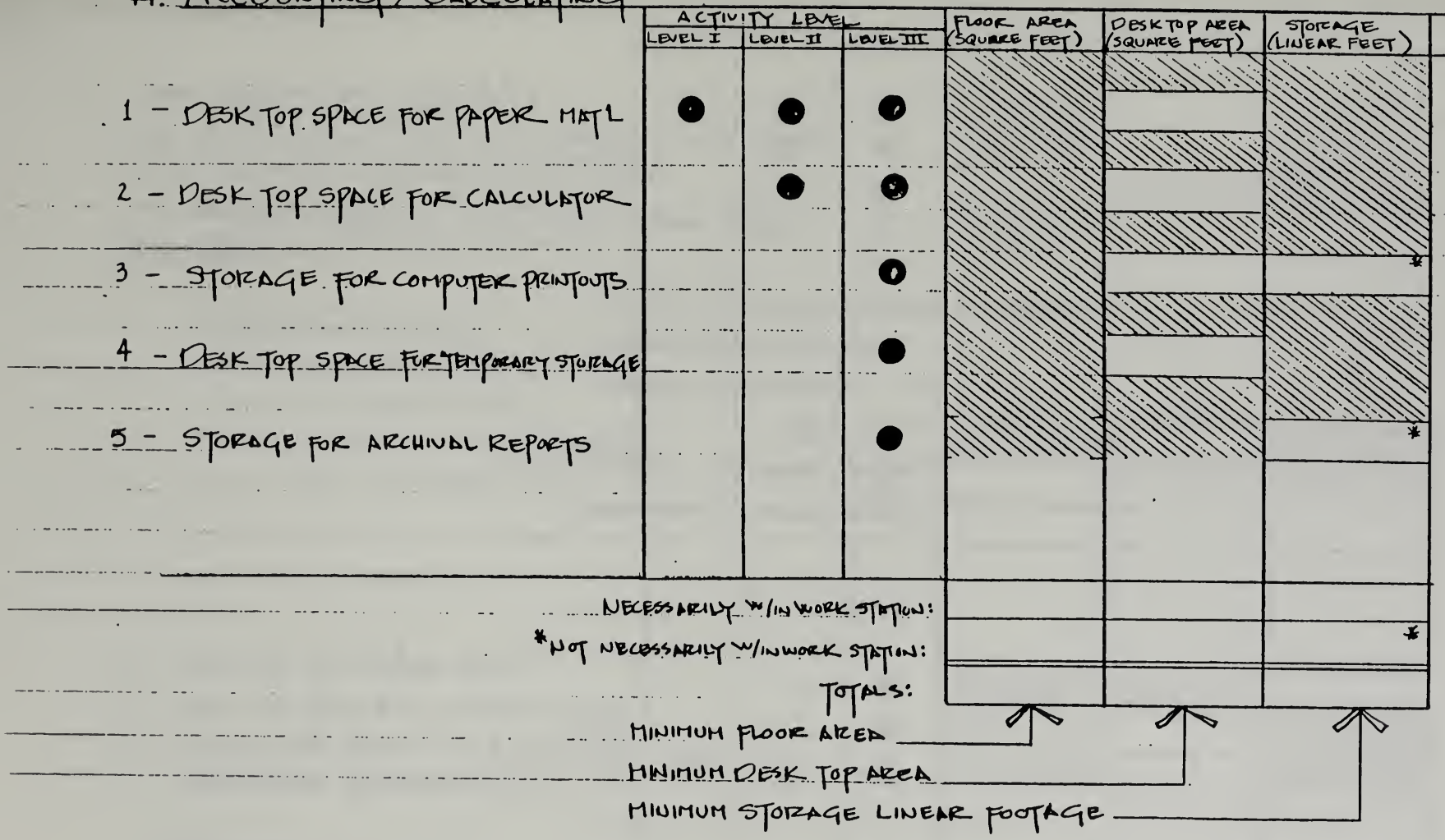
MINIMUM STORAGE LINEAR FOOTAGE

FOOTNOTES:

[1] FOR ONLY RARE USE (LEVEL I), TYPEWRITER CAN BE LOCATED EXTERNALLY.

[2] INCLUDE IF SECRETARIAL WORK STATION.

H. ACCOUNTING / CALCULATING



I. MANAGING/SUPERVISING [1,2]

	ACTIVITY LEVEL			FLOOR AREA (SQUARE FEET)	DESK TOP AREA (SQUARE FEET)	STORAGE (LINEAR FEET)	NOTES
	LEVEL I	LEVEL II	LEVEL III				
FOR FOLLOWING SEE SEPARATE OFFICE TASK/ACTIVITY HEADING-							
-MEETING W/ PEOPLE							
-COMMUNICATING VIA TELEPHONE							
-REVIEWING MATERIAL							
ADDITIONAL REQUIREMENTS-							
1 - DESK TOP SPACE FOR PAPER MAT'L	●	●	●				
2 - DESK TOP SPACE FOR DICTATION DEVICE			●				
3 - STORAGE FOR PAPER MAT'L			●				
NECESSARILY W/IN WORK STATION:							
NOT NECESSARILY W/IN WORK STATION:							
TOTALS:							
MINIMUM FLOOR AREA							
MINIMUM DESK TOP AREA							
MINIMUM STORAGE LINEAR FOOTAGE							

FOOTNOTES:

[1] CONVERSATIONAL PRIVACY CRITICALLY IMPORTANT FOR MANY MANAGERIAL AND SUPERVISORY TASKS.

[2] FOR TASKS INVOLVING INDIVIDUAL MEETINGS WITH OTHERS, SEE OFFICE TASK ACTIVITY "F".

J. DRAFTING/DRAWING

	ACTIVITY LEVEL			FLOOR AREA (SQUARE FEET)	DESK TOP AREA (SQUARE FEET)	STORAGE (LINEAR FEET)	NOTES
	LEVEL I	LEVEL II	LEVEL III				
1 – DRAFTING TABLE	○[1]	●	●		1*		LOCAL TASK LIGHTING NEED
2 – DESK TOP SPACE FOR LARGE DRAWINGS		●	●				
3 – STORAGE FOR ROLLED DRAWINGS		●	●				
4 – STORAGE FOR DRAFTING UTENSILS		●	●				
SPECIAL CONDITIONS – IF COMPUTER-AIDED DESIGN & DRAFTING (CADD) USED:							
5 – DESK TOP SPACE FOR MONITOR/KEYBOARD		○[2]	○[2,3]		*		LIGHTING GLARE CONTROL N
6 – FLOOR SPACE FOR SYSTEM UNIT		○[2]	○[2,3]	*			
NECESSARILY W/IN WORK STATION:							
* NOT NECESSARILY W/IN WORK STATION:				*	1*		
TOTALS:							
MINIMUM FLOOR AREA							
MINIMUM DESK TOP AREA							
MINIMUM STORAGE LINEAR FOOTAGE							

FOOTNOTES:

[1] IF USED ONLY RARELY, MAY BE LOCATED OUTSIDE OF WORK STATION.

[2] CADD SYSTEM MAY BE IN SHARED LOCATION W/IN WORK STATION OR OUTSIDE OF IT.

[3] IF CADD NOT PART OF CURRENT NEEDS, STRATEGY SHOULD BE DEVELOPED FOR MAKING WORK STATION EXPANDABLE TO ACCOMODATE EQUIPMENT AT LATER DATE.

K. USING VDT (VIDEO DISPLAY TERMINAL)

SPACE NEEDED FOR THE FOLLOWING:	ACTIVITY LEVEL I	ACTIVITY LEVEL II	ACTIVITY LEVEL III	MINIMUM SPACE REQUIREMENTS: FLOOR AREA (SQUARE FEET)	DESK TOP AREA (SQUARE FEET)	STORAGE (LINEAR FEET)	NOTES
1 – DISPLAY MONITOR & KEYBOARD	●	✓●	●		7.5		
2 – SYSTEM UNIT	●	○[1]	○[1]	[1]	[1]		
3 – DOCUMENT STAND	●	○[2]					PRIMARILY FOR SECRETARIAL US
4 – DESK SPACE FOR PAPER MATERIALS		✓●	●				
5 – STORAGE FOR MANUALS	●	✓●	●			2.0	
6 – STORAGE FOR REFERENCE MAT'LS			●			*	
7 – STORAGE FOR COMPUTER PRINTOUTS			●				
8 – STORAGE FOR ELECTRONIC MEDIA		✓●	●			1.0	
9 – PRINTER AND PAPER		✓●	●	*	*		MAY NEED TO ISOLATE ACOUSTICALLY
10 – POINTING DEVICE & PAD		●	●				
11 – EXTERNAL DISK DRIVE UNIT	●						
12 – SECOND DISPLAY & KEYBOARD			●				
13 – SUPPORT EQUIPMENT (IMAGE SCANNER, O.C.R, OPTICAL DISK DEVICE)			●	*	*		MAY NEED TO ISOLATE ACOUSTICALLY
14 – DICATION DEVICE	○[2]	○[2]	○[2]				
NECESSARY W/IN WORK STATION:					7.5	3.0	
* NOT NECESSARILY W/IN WORK STATION:				*	*	*	
TOTALS:					7.5	3.0	

FOOTNOTES:

[1] DO NOT INCLUDE IF DISPLAY NORMALLY ON TOP OF UNIT.

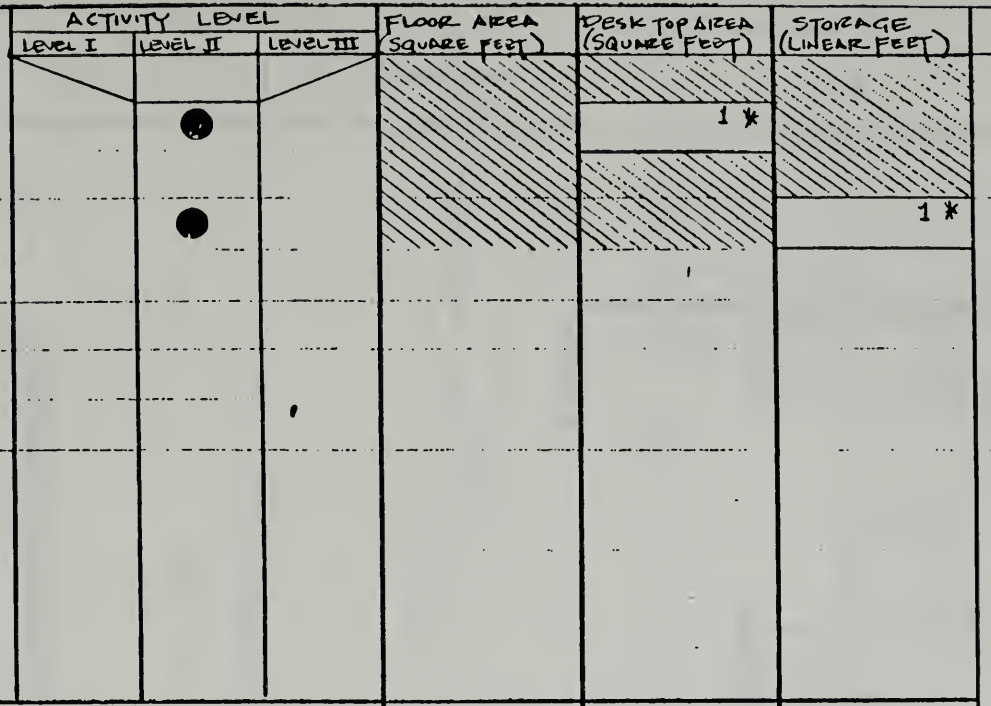
[2] INCLUDE IF SECRETARIAL WORK STATION.

FOR THIS ACTIVITY:

- MINIMUM FLOOR AREA
- MINIMUM DESK TOP AREA
- MINIMUM STORAGE LINEAR FOOTAGE

L. USING MICROFICHE

- DESK TOP SPACE FOR MICROFICHE MACHINE
- STORAGE FOR MICROFICHE MEDIA



FOOTNOTE:

* IF USED LESS THAN 2HRS/DAY, MAY BE LOCATED OUTSIDE WORK STATION.

NORMAL OFFICE TASKS/ACTIVITIES	MINIMUM REQUIREMENTS: W/IN WORK STATION			MINIMUM REQUIREMENTS: NOT NECESSARILY W/IN WORK STATION			NOTES
	FLOOR AREA	DESK TOP AREA	STORAGE	FLOOR AREA	DESK TOP AREA	STORAGE	
A. READING/WRITING		14.5 ϕ	7.0′				
B. ANALYZING		9.7	3.0				
C. REVIEWING MATERIAL							
D. FILING (HARD COPY MATERIAL)							
E. TALKING ON THE TELEPHONE		(2.0)	1.0				
F. MEETING W/ PEOPLE							
G. TYPING							
H. ACCOUNTING/CALCULATING							
I. MANAGING/SUPERVISING							
J. DRAFTING/DRAWING							
K. USING VDT		7.5	3.0				
L. USING MICROFICHE							
	1	2 31.7	3 14.0	4	5	6	

9'-0"
"0-,5
"0-,8

8'-0"
6'-0"

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10. SUPPLEMENTARY NOTES

☐ Document describes a computer program; SF-185, FIPS Software Summary, is attached.

11. ABSTRACT (A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here)

The process employed to design office workstations in federal buildings has been largely influenced by space considerations in recent years. In the private sector, there has been an increasing trend toward designing workstations based on the activities performed at them.

This report describes a workstation design process, starting with an analysis of the activities performed, then deals with environmental, building design, space planning and furniture issues required for designing workstations suitable for a range of office activities. A limited number of generic workstations are presented, as examples of types of configurations that might meet specific office requirements. These examples are illustrative of the results of following the design process suggested and are not intended as recommended approaches for particular workstation designs. Technological, ergonomic, and organizational factors are considered from the standpoint of their design implications for automated workstations. Criteria and checklists are included as an aid to making workstation design decisions.

12. KEY WORDS (Six to twelve entries; alphabetical order; capitalize only proper names; and separate key words by semicolons)

acoustics; design process; ergonomics; furniture systems; office furniture; wiring; workstation design

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