NBSIR 83-2784-1

The Automated Office - An Environment for Productive Work, or an Information Factory?: A Report on the State-of-the-Art

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Center for Building Technology
National Engineering Laboratory
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U.S. DEPARTMENT OF COMMERCE, Malcolm Baldrige, *Secretary*
NATIONAL BUREAU OF STANDARDS, Ernest Ambler, *Director*

ABSTRACT

This study is a report of research findings and recommendations covering topics which influence automated office design. The subjects covered are: office design, office information systems, organizational factors, ergonomics, technology, and communications.

Advances in technology, coupled with the explosive growth of office-based work have resulted in the automation of many offices. To date, technology has provided the major impetus for automation, with mixed results. Systems frequently do not meet the needs of the end-user because of the lack of appropriate planning. Design issues are particularly neglected during planning, resulting in problems with the visual, thermal, and acoustic environment in many offices. These effects are particularly detrimental since many office automation, management, and design experts agree that the quality of the environment is especially important in the electronic office - to offset the impersonality of many office tasks, and changes in work procedures resulting in limited social interaction with colleagues. These issues are discussed as they relate to the development of design guidelines and criteria for automated offices. The report contains an extensive bibliography, dealing with the topics cited above.

Key Words: acoustic and visual privacy; design criteria; ergonomics; lighting; noise; office automation; office design criteria; quality-of-life; space planning; VDT's (video display terminal); workstation requirements.

PREFACE

During the past decade, many new products and systems directed toward the automation of office functions have been introduced into buildings, and countless others are being developed. The automation of professional, clerical, and technical activities has changed the nature of many of these jobs and is likely to have profound consequences for the design of federal office buildings. However, these potential design implications have not been studied in any systematic way, and therefore are not well understood. The present project is designed to develop a better understanding of the relationship between office design and the potential consequences of the "office of the future".

In order to effectively house the automated office, Public Buildings Service, General Services Administration (PBS/GSA) must be capable of specifying environmental, spatial, and other criteria to support the administrative and operational activities performed in federal buildings. The development of such criteria and guidelines is the long-term objective of this project. A necessary prerequisite for developing such office design criteria is the identification of the characteristics of the physical environment which merit design consideration. The present phase of this project is focused on this issue, using the following approaches: 1) a literature search, 2) interviews at organizations and with individuals at the forefront of office automation, 3) mailed inquiries to selected A/E firms, and 4) attending meetings and conferences. The findings obtained from these activities are reported in this paper.

Our findings to date suggest that the environmental attributes and requirements of offices which are of particular importance for automated office activities include the following:

- Lighting - its quality, intensity, location of source, distribution, adaptability, and control all strongly influence the performance of office tasks, and the acceptability of the work surrounds.

- Acoustics - noise is a major distraction in many open-office design situations; many of the new office systems are quite noisy (e.g., printers, optical character readers), and must be isolated from staff activities requiring analytic work; privacy is essential to many activities and must be accommodated in open-plan designs.

- Thermal - thermal comfort of the office staff must be maintained despite the introduction of electronic equipment which produces a considerable heat load.

- Indoor Air Quality - energy conserving designs have resulted in the trapping of air pollutants produced by occupants (e.g., cigarette smoke) and building materials.

- Spatial Requirements - tradeoffs must be considered between the reduced needs for paper file storage, and the possible expanded space requirements for work stations to accommodate new technologies; functional grouping of activities should be considered to maintain group cohesiveness to offset reliance on electronic communication.

- Flexibility - electrical and telecommunications systems must be designed to facilitate future changes and expansion; modular systems are needed to accommodate change in work station.

- Integration - of building systems with office automation requirements.

- Special Purpose Facilities - audio and teleconferencing activities will require unique environmental and telecommunications requirements.

This report, supplemented with.findings to be obtained in interviews with designers, a roundtable, and a further review of design guideline documents for buildings and interior spaces, will serve as the basis for establishing interim guidelines for federal office buildings. The guideline document is intended for the use of the PBS/GSA-central and regional offices, the federal design community, and architectural and other design firms which serve the needs of the federal government.

In developing the present report we have been sensitive to the issue that if design criteria and guidelines for office automation are to be valid, they should be based upon "hard information" to the greatest extent possible, not opinion. That is, design recommendations should be supported by a body of information (preferably based upon research findings), which explain the rationale for them. A major objective of this study has been to locate and describe these findings.

Design guidelines, if they are to be useful, must not only be directed toward the environmental attributes of buildings, but must be responsive to the particular needs of an organization and its staff. In the case of the automated office, a major consideration is the desirability of taking advantage of technological advances as a means of advancing organizational objectives, while responding creatively to its most important asset - its work force.

The subject of office automation has been treated extensively in publications emphasizing technological and communications advances, and therefore this report touches only briefly on these topics, as they relate to building design. Our emphasis instead is on the office as part of an organizational environment; a place concerned with the development, processing and transmission of information, and the impact of these office activities on the satisfaction and effectiveness office workers - clerical, managerial, and professional. A major consideration is the examination of the processes, taxonomies, and analytic methods used in the development of information for planning office automation systems and the environment in which they are intended to function.

Thus far, many offices which have automated their functions have done so without adequate planning. This hardware driven approach has resulted in a situation where automation has influenced word processing activities and other clerical and support functions but has had limited success in supporting professional and management activities - those which comprise the major portion of the overall office expenditure. The absence of detailed planning in too many instances has led to a neglect of the design implications, the effects of automation on office workers, and the consequences of such changes on the organization as an entity. The present report deals with these issues in considerable detail.

Although the report is organized into the topics such as 'Design', 'Ergonomics', 'Organizational Factors', and 'Office Information Systems', the material covered is closely interrelated and therefore cannot be readily organized into these, or any other set of "pigeonholes". Consequently, a given idea is often expressed in several different contexts. To some extent, this redundancy was a matter of conscious choice, to suggest its broad range of applicability, since a major objective of this effort is to provide a sense of the close interdependencies of organizational, ergonomic, and design issues as they relate to design guidelines and criteria.

While an extensive range of literature has been covered in this report, it cannot claim to be a comprehensive treatment of the subject of office automation and design - the data base is simply too large to be covered by any one study. Additional reference sources are provided in the Bibliography for those who want to pursue these subjects in more detail.

The Appendix contains examples of several data collection methods devised to obtain information pertaining to Office Automation Design Issues. The report also has a Glossary and an Index.

An executive summary of this report has also been prepared, and is available as a separate document (NBSIR 83-2784-2).

ACKNOWLEDGMENTS

I would like first to express my particular appreciation to Erma Striner of the Public Buildings Service of the General Services Administration for her assistance, guidance, and unfailing enthusiasm for the work reported here. John Murray of the General Services Administration provided technical assistance on the project, and contributed to the success of several of the site visits performed as part of this study. Belinda Collins, Terje Jacobsen, and Ted Hattenberg served as technical readers for this paper, and their sugggestions for revising early drafts are gratefully acknowledged.

Finally, I would like to acknowledge the work performed by Keith Mackley in producing the illustrations in this document, and the typing support provided by Ulesia Gray, Brenda Thompson, and Mary Ramsburg of the CBT Word Processing Center.

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1. INTRODUCTION

Office design today is readily traceable to a tradition dating back more than one hundred years. The typical office is designed to generate, control and distribute information in the form of paper. In the 1950s, repetitious operations involved in the handling of masses of data were systematized for computer processing, and the design of offices had to accommodate this function. Data processing was one important forerunner of office automation, while word processors and advanced telecommunications constituted two other driving forces toward the office of the future.

The term 'office automation' (OA) is a vague and inexact one, but has been primarily used to refer to any trend in office development where new technology is applied to assist office workers in the performance of their jobs. OA represents an integrated systems approach to the implementation of new and improved ways of handling information. It is the application of technology to create, manipulate, store, reproduce, retrieve, and disseminate information in an office environment.

The advent of office automation (OA) has already had an important influence on the activities performed in offices despite its rather recent origin. There is every reason to believe that this trend will accelerate as a result of new technologies, and organizational changes instituted to better harness this capability. Furthermore, the change in the way that office functions are conducted are likely to have profound implications for office design. For example, an executive with a private secretary in an outer office and staff support "down the hall" typifies many corporate offices today. Such an office layout is designed to facilitate personal contact where the primary sources of information are verbal, and in the form of written memos. The electronic office provides a very different perspective. An executive is not likely to be as dependent on staff assistance in many day to day operations. Rather, a centralized data base will be available for access on a personal computer terminal. Similarly, all personnel who have reason to access the centralized data base will be able to do so. Physical space layout will therefore have much less influence on the ability of people to communicate with one another than is the case today (except for telephone conversations).

Colleagues working on related activities will be able to readily exchange information electronically regardless of their respective locations.

However, the availability of technology to process information electronically and impersonally has its drawbacks as well as its advantages. A sense of common purpose (e.g., teamwork) is accepted as an important characteristic of all work environments. The organization of workstations should therefore accommodate the desire for people to identify with a particular work group, and facilitate informal social interactions as well as work-oriented personal communications.

The overriding design concern is the need for flexibility to accommodate change - organizational and technical. Technology advances are occurring so rapidly that it is very difficult to make reasonable predictions about the design implications of future OA systems. As a result the emphasis is on design approaches which can accommodate a variety of possible "futures". The flexibility sought is in terms of such factors as the location and configuration of work stations, electronic outlets, lighting fixtures and office partitions. Another major consideration is the need to plan for the expanded use (and linking) of electrical and telecommunications technology as future hardware and systems become more generally available. The electronic office will permit greater control of individual workstation environments, thereby providing the capability of countering some of the adverse effects associated with the impersonality of such offices. Organizational decisions will determine whether this potential will be realized.

The space requirements needed to house particular activities are undergoing rapid change. The need to accommodate extensive filing systems for paper documents is diminishing with the advent of electronic storage and microfiche systems. But at the same time, the traditional desktop used for typing and other paper generation activities is being replaced by a workstation, needed to accommodate an ever increasing variety of electronic hardware and systems. However, despite the trend toward the electronic office, papers are not likely to disappear from the office in the foreseeable future.

Just as all people differ from one another in important ways, no two organizations are alike. Each one is unique as a result of a combination and the interaction of such factors as goals, ways of doing business, management style and values and the personal and social characteristics of their staff. The distinctive character of a given organization is sometimes termed its 'culture'. One of the major indicators of the culture of an organization is concerned with the view of its workforce. Management theorists such as Argyris (1), Likert (2), and Katz and Kahn (3) have examined organizational practices from this perspective and have formulated a variety of concepts to describe and explain different management approaches to achieve organizational objectives.

In general, two opposite approaches have been identified. One is a highly centralized style, with most decisions being made "at the top" of the organization and communicated below by subordinate managers to their staffs. At the other extreme is a decentralized procedure, which is aimed toward obtaining maximum participation in decision making at all organizational levels.

Driscoll (4) views the office automation scene today, as well as current trends, and concludes that the predominant mode of doing business is consistent with the centralized "model" indicated above, which has been largely rejected by management theorists. The humanistic style advocated by Driscoll recognizes the need to deal with quality-of-working-life (QWL) issues in the workplace, and assumes that workers are motivated to do challenging and meaningful work and to expand their capabilities for their personal growth and for overall organizational effectiveness. Driscoll contrasts the centralized management approach (which he terms 'systems analytic') with a decentrailized humanistic one, in table 1.

Table 1. Alternative Technological Paths (Driscoll)

	System Analytic	Humanistic
Assumptions about human nature	lazy, untrustworthy, need outside control	motivated, trustworthy, self-control
Immediate function of office automation	allow outside control, reduce skill requirements, provide information to key decision-makers	provide feedback to individual operators, utilize and increase skills and knowledge of operators
Unit of analysis	Indiviudals, tasks	groups, organizational units, functions
Scope of organizational objectives	efficiency	effectiveness, quality of work life
Target group	key decision makers	all organizational members
Constituency	top management	all organizational members
External effects on society	increase unemployment, threat to physical and mental health, little impact on productivity	decrease unemployment, beneficial impact on mental health, increased productivity

Iodahl (5) points out that the earliest metaphor for office automation was "word processing" which implied not only technology, but a production-style organization characterized by centralization, extensive rules and procedures and the replacement of men by machines. This orientation is in marked contrast to the current view of the office as a place where information and communication systems are centralized to serve organizational purposes, and where important decisions have to be made in an ad hoc manner with incomplete information. Lodahl observes that most modern offices house routine tasks that can be readily structured for automation purposes, and specialized ones which distinguish one working group from another. He indicates that the office design task is basically that of identifying the routine tasks and those that are specialized, and providing the tools necessary to accomplish each of them. Design is accomplished by means of an interactive process between the user subgroup and the designer. The emphasis is not on developing procedures and tools that are standardized for the entire organization, but rather to determine which subgroups have unique sets of requirements that should be accommodated for overall organizational effectiveness. He terms this approach as "custom design." Table 2 contrasts traditional and interactive design emphases.

In an examination of the prospects for future office buildings, Downs (6) indicates that the most important influence on them will be the new electronic technology for office work. It will have a decentralizing overall impact but

Table 2. Traditional and Interactive Design Approaches (Lodahl)

The Traditional System Design

Emphasizes:

- Standardization of behavior
- System controls the people (Centralization)
- Search for repetitive elements
- Seeks predictable performance
- Avoids changing itself
- Transfers of standard design elements
- Punishment of nonconformity

Interactive Design

Key Elements:

1. Identify separable subunits ("Boundary location")
   - Functions
   - Goals
   - Languages
   - External relations

   "Custom" design = caters to uniqueness

2. Scope parent organization
   - Goals
   - Constraints
   - External environment
   - Investment in current structure, style, philosophy

Emphasizes:

- Fits technology to ongoing processes-tolerates uniqueness
- People control system (decentralizaiton)
- Seeks high payoff processes
- Supports outstanding performance
- Allows revision, iteration
- Transfers design approach, not identical elements
- Tolerates people, subunit variations

Interactive Design: Sociotechnical Implementation

"Re-Freezing"

- Redesign of jobs, roles
- Redesign of social support system
- Redesign of recruitment, selection, training

not eliminate the need for face-to-face contact in many situations. He forecasts that the office work force will continue to grow, accelerating the trend toward a higher percentage of the total work force being engaged in service oriented activities. Many of the routine clerical operations are likely to be mechanized, and the increasing sophistication of the technology will generate more interaction and communication within and among organizations. Operating this equipment will require more skills than current jobs demand, and therefore organizations will try to recruit more skilled workers, and devote more resources to continually training them. More office space will therefore be devoted to meeting areas, training rooms and media presentation facilities to accommodate these activities. The additional requirements for training and seminar space will also meet the anticipated movement toward greater interaction and participation by staff members in the organizational decision making process. While a small percentage of workers will work at home, keeping in contact with their offices by means of computers, most office work is likely to remain where it is today because of the desire to keep in personal contact with colleagues and the need for client interactions.

More buildings are expected to be constructed around atriums to offer more "outside space", save energy, and provide the opportunity to integrate the atrium with the building in performing work and social activities.

While the physical setting of an office provides the direct support for conducting required activities in a space, Becker (7) suggests that the environment also serves a catalytic function in that it can promote or inhibit discussions, meetings, social interactions and a variety of formal and informal communications. (See figure 1.)

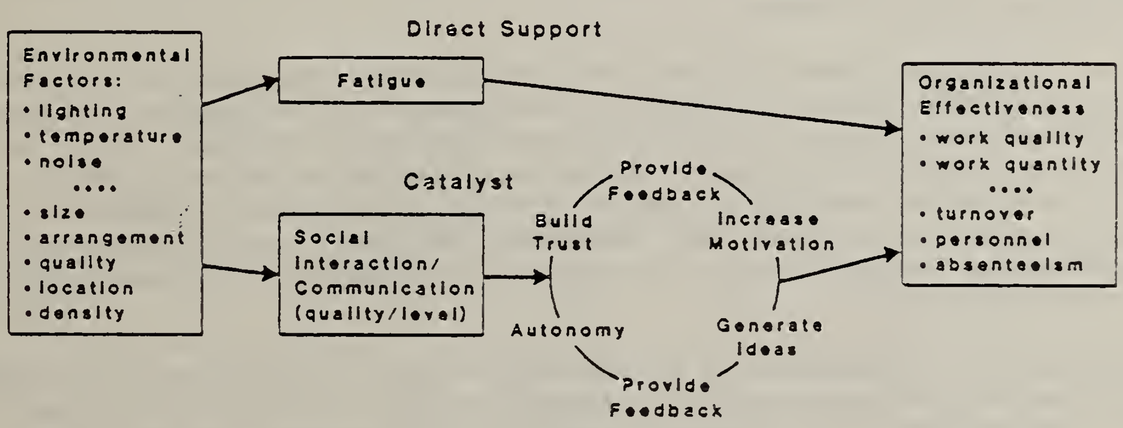

Figure 1. Environment as support and catalyst (Becker)

Space characteristics, lighting, temperature levels, indoor air quality, the opportunity for movement, all have the potential effect of playing a positive or negative role with respect to the acceptability of the environment for performing necessary tasks and/or for general feelings of satisfaction. Since organizations are housed in buildings, physical settings are created for them. The question is not whether these decisions are made, but how, and on what basis. Architects and space planners are sometimes motivated to ensure that the environment that they create cannot readily be modified by the users. In pursuit of this goal, a master plan is created which promotes order and conformity. Visual order is intended to reduce ambiguity while disregarding differences in individual requirements for performing similar activities. In large organizations, environmental conditions are typically standardized for individuals within job categories. Variety is most apparent at the upper levels of management, where the jobs themselves are more diverse.

Becker argues that many office jobs are intrinsically routine and rather boring, and the environment can serve to compensate for the performance of such activities. He further notes that in open-space offices, environmental components are expressed in terms of common elements, so differences in organizational levels are more subtle than in traditional offices. Moreover, with the increase in office automation the workstations of managers and support personnel will become even more similar, and the quality or office environment will become increasingly important to most office workers.

Becker views the automated office environment as having the potential to improve productivity by responding to the particular needs of individuals. Performance standards are advocated as a design approach in response to the particular activities in which the individual is engaged, e.g., communication privacy, interactions. The environment needed to perform these functions can be created in any number of ways, to suit personal requirements and preferences. The decentralization of decision making is seen as a further step in improving organizational effectiveness.

He cites a number of investigations which suggest that employee participation in decision making results in greater job satisfaction and improved productivity. Such decisions must be perceived by the staff as being important ones. In the context of the office environment, decisions about office size, location, degree of enclosure, amount and type of storage space are all considered to be important ones. He indicates that management maintains control by developing and implementing procedures that are used by subordinates in accomplishing organizational goals.

In examining the relationship of OA and design Mazo (8) forecasts that larger workstations will be required for employees having a variety of electronic devices. Increased use of computer terminals will require flexibility in planning the wiring and cable runs. Individual circuits will often be required to support advanced computerized workstations. Special attention will have to be given to voltage regulation, power surges and static electricity because of the sensitivity of computerized equipment to the electrical environment in which they operate.

Electronic offices will require that more services be centrally located. Larger, complex reproduction centers, with copying, printing and duplicating facilities, will be prevalent. More filing will be centralized to improve effectiveness and save space. Communication centers and conference facilities for television and/or audio based meetings are likely to be common features of offices. Equipment staging, assembly, and maintenance areas will have to be available, as well as storage facilities for equipment and modular office systems (for open planned spaces). Above all, Mazo stresses the need for flexibility to accommodate the changes that are likely to occur as a result of technical advances and organizational requirements.

Office automation experts are in general agreement that in too many instances organizations purchase office technology without sufficient planning. Lack of appropriate planning is given as the reason for the limited success of many OA systems, and the outright failure of others. For the most part the planning necessary must be undertaken by, or at least with, the using organization. This is the case because OA is seen as a means of advancing organizational goals by improving methods and procedures used to process information. It is therefore necessary to have a detailed understanding of organizational goals and the procedures currently in place, to accomplish them. When this information is available, then technology should be examined as a potential means of improving operational efficiency. This planning information is also a vital ingredient of the architectural program, if the building design is to make an effective contribution to organizational effectiveness.

2. BACKGROUND OF OFFICE AUTOMATION

Giuliano (9) believes that most offices today are in a "pre-industrial" stage of development, where there is little conscious attention of efficiency, work flow or productivity. The information handling devices that are present (telephone, copiers, etc.) are not used to their maximum advantage. Varied personal styles are accommodated and loyalty and mutual respect are important ingredients which contribute to the success of organizations. This style works as long as the operation is small and is fairly simple. Increases in size and complexity cause disruptions in work.

A major response to complexity has been the introduction of the industrial-stage office, where work is designed as a paper production line. Each worker performs a highly specialized task and passes the work on to the next employee. To create an assembly-line of work flow requires analysis of jobs into discrete tasks, and standardization of methods to accomplish them. Responsibility is fragmented and bureaucratic organizations are required to coordinate activities. This approach has led to many boring jobs and a proliferation of errors made by people who have limited access to all of the pertinent information needed to complete a task properly.

Vendors of automated equipment for offices have repeatedly justified the need for such devices on the basis that business has spent only $2500 on capital equipment for the office worker while the factory worker has been supported by approximately ten times that amount according to Uttal (10). These numbers are contested by Michael Zisman, an office automation consultant, who is typically named as the source for these data. Zisman (10) indicates that he used those numbers because it represented the "folk wisdom" of the community. He notes that "investment looks low because companies expense their office-related costs instead of capitalizing them. If you capitalize actual expense streams for the office, you'll find companies have already invested $15,000 to $20,000 per office worker."

In defining the scale of operations conducted in offices, Connell (11) cites figures for 1979 which indicate that the total cost of business office activities in the United States was $800 billion, with labor costs being $600 billion of that amount. Furthermore, he notes that studies have consistently shown a yearly increase in these costs ranging from 12 percent to 15 percent.

Martin (12) cites a Booz, Allen & Hamilton study indicating that wasteful office activities cost American businesses $300 billion per year - double the total annual investment in research and development. The largest office expense is payroll. The typical cost breakdown is: personnel - 90 percent, space - 8 percent, equipment - 2 percent. He also indicates that the automating of office activities often starts with the telephone and mail systems, estimating that every year businesses make more than 100 billion phone calls and mail in excess of 105 billion documents. The charges associated with these two types of communication is said to be more than $30 billion per year. U.S. companies spend twice as much money on the electronic transmission of information as they do on first class mail.

Zisman (13) examined several organizations in the process of automating their operations and noted that their experience may be described in terms of four stages of growth. (This concept was first formulated by Gibson and Nolan (14) in an analysis of electronic data processing (EDP) operations).

1. Initiation. Organizations are said to introduce office automation as a means to take advantage of technological opportunities to reduce costs and/or increase productivity by the use of mechanized office equipment. This step is often initiated in word processing activities, where the emphasis is on the more efficient production of paper, rather than the reduction of paper work.

2. Expansion. After word processors have been introduced into the workplace with some measure of success, then the objective is to replace the paper flow of information by electronic systems. The emphasis here is on the mechanization of existing office tools such as the calendar, files, and "in baskets". As more and more organizational units have such tools, there is a problem of integrating them into a coherent system, because the question of compatibility of diverse hardware elements has not been sufficiently examined.

3. Formalization. Lack of integration and rising costs leads management to decide that centralized authority is needed to provide proper planning. There is also a change from mechanizing tools to automating processes. That is, formal office procedures are institutionalized, and are then controlled by means such as management information systems. Office functions are now being automated - which addresses the problems of the manager, not only those of the clerical staff.

4. Maturity. This is the final stage of automation, where routine processes are automated and "intelligent" work stations are linked in networks to serve the creative needs of the users.

Spinrad (15) concludes that the first products designed to modernize office procedures were made to emulate the traditional ones. For example word processors and facsimile equipment were enhanced versions of an office system based upon paper operations. The system elements were electronic, but the system itself was based upon manual operations. The working unit of the system was a piece of paper with an image upon it. Paper is extremely flexible: it can be mailed, carried, filed, copied, scribbled on. It is extremely flexible medium, whose attributes are difficult to duplicate by electronic means. Paper also provided a standard size for filing, duplicating, mailing, and other functions that had to be performed. The paper based system served as a model for developments in office automation, where individual elements had to be designed as part of a coherent system to be used for creating, displaying, printing, communicating and filing electronic documents.

Ness, et al. (16) point out that automating the office involves mechanizing procedures which are routine and predictable, while allowing for human intervention in unusual circumstances. Since office environments differ from one another and are often subject to change, systems should be designed to accommodate these changes by being flexible.

To the extent that processes are regular and information is structured, machine interactions can be made conversational - prompting the user for information needed to complete a particular process. This capability makes limited demands upon the operator for knowing computer procedures, permitting greater concentration on the functions to be performed. This approach has the advantages of simplifying work, maintaining uniformity, and enabling formats to be changed in an entire organization with minimum disruption to activities.

The standardization of office systems elements is consistent with a modular approach which can accommodate a mixture of manual and automated functions. For example a typist can prepare a document by typing in some material and retrieving information from the files, which consist of standardized elements included in many documents. Since proper time management is considered to be the most important factor in office productivity, time wasting activities should be minimized and duplication of effort avoided. A major goal is therefore that any item dealt within an office should be handled only once. For example, data in any form, once entered into an electronic file by means of keystrokes (or any other method) should never again have to be reentered. Changes should be achieved with text editing tools.

Existing organiations fostered this approach because of the desire to standardize tasks at their lowest level of detail as a means of increasing efficiency. This is especially likely to occur when:

- The activities are relatively simple and easily standardized as in banking, order entry, parts management.
- The patterns and contents of transactions are relatively stable, as in airline reservation systems.
- The numbers of transactions is large, as in payroll systems.
- A rather straightforward system of evaluating costs and benefits is available to assess possible future changes.

The trend toward the breakdown of tasks into components paradoxically leads to complexity rather than simplicity, when it is extended beyond a critical scale, According to Strassman (17) for example, if five separate units deal with a given customer, inter-organizational communication links among these units are necessary in order for all of them to keep current on a given transaction. As other functional missions are created (e.g., safety, security), additional channels are created. Strassman has found that in many organizations, one transaction requires upward of 40 messages to keep files current.

Possibly the single most important factor paving the way to the automated office is the change which occurred in the production of typed materials. The advent of word processing (WP) provides a means of electronically coding alphanumeric information in contrast with the mechanical systems used before. The electronic coding of information was a necessary precondition for all of the advanced technologies which have followed in its wake - electronic mail, teleconferencing with electronic displays, remote printing and display devices, etc.

One of the most important and time consuming activities performed in the office is the preparation of documents. For the most part, reports are produced today in the same manner as that used a generation ago. The many activities such as text and graphic preparation, illustrations and photographs are individual operations which are coordinated at the final phase of a project. Moreover, these tasks are frequently done in serial fashion, rather than in parallel.

This process is a very time consuming and inefficient one and understandably has received considerable attention from manufacturers of automated equipment and organizational managers.

Word processing equipment and electronic storage media have provided two of the critical prerequisites to radically change the methods available to prepare documents. Many systems exist today which permit the manager and professional to combine work tasks which in the past had to be performed separately, e.g., text preparation and the acquisition and analysis of data from electronic storage. Another tool becoming available is the intelligent copier, based upon laser or optic fiber technology. These systems can generate documents that include graphics or any other material that can be digitally coded.

Connell (11) indicates that the most mature office technology is data processing, but the most widely publicized one is word processing. In comparing the two, he cites several similarities and major differences. The machines used for them are very often the same and the information stored within them takes the same form, resulting in a tendency to characterize word processing as an offshoot of computing equipment. However, when they are examined in terms of the operations performed and the skills required by the operators, another picture emerges.

Information stored in a computer is defined logically be a sequence of operations and once stored in memory the user plays a monitoring role except for interactive systems. But even in these instances, the user must follow a predesigned set of logical procedures. With word processing equipment, information is not stored in accordance with a set of logical rules, instead the user reads the information on the screen and interprets it. Without the human interface the data displayed serves no function, because it is the interaction of the user with the machine that defines the successful operation of the "system". In general, the focus of attention for the new office technologies is on the user to a much greater extent than it is in data processing applications.

A second major difference between data processing and word processing is with respect to the approach taken to training. In the computer and telecommunications world, training covered not only how to operate machines, but how they functioned internally-based on logical structures which can be controlled by appropriate instructions. In word processing, users are taught that if they push a given key, then the machine will perform a particular function. Training is therefore focused on the user as an operator rather than as a programmer. When people trained in data processing and telecommunications work together with those in office technologies, it is not too surprising that there are several communications barriers with respect to conceptual understanding as well as the different jargons employed.

McNurlin (18) describes the automated office as an integrated system, interconnected by a communications network. The electronic network might connect the following services: "word processing for the generation of formal and informal correspondence, electronic message systems for person-to-person electronic communication, facsimile for rapid document and graphic transmission, electronic 'file cabinets' for document storage and retrieval, and links to various corporate files and outside services. All of these services would be accessible from electronic work stations."

McNurlin (19) presents the following as a list of system components that she encountered in her study of automated office components (table 3).

Implicit in the automated office is the use of computers - computers for controlling every facet of the system. So the automated office is really a multi-function, integrated, computer-based communication system that allows many business communications to be performed in an electronic mode. An example of one of the first integrated systems is the ARPANET, described by Uhlig, Farber and Blair (20).

The ARPANET is described as an example of an advanced communications network. It is a data network started in the 1960s by the Advanced Research Project Agency (ARPA) of the Department of Defense, with the purpose of sharing resources, which included hardware, software, and data bases. ARPANET consists of a set of autonomous, independent computer centers which are interconnected and use a standard transmission method, to permit interactive resource sharing among all participants. A "host" computer is located at each center, and connects with the network by means of an interface message processor (IMP), which is the standard interface for the network. It also handles messages and controls messages routing along alternative paths. Messages are transmitted from center to center in packets, using a distributed store-and-forward approach. Each packet contains about 1000 bits; the transit time through the network takes about two seconds.

The Information Sciences Institute (ISI) is one of the main computer centers of the ARPANET, and operates in an automated office environment. ISI employees have access to all other people on the net. Almost all text and data generated at ISI are stored in electronic form - including memos, messages, research drafts and papers, personal calendars, and software. Electronic files are created using any header - e.g., project name, subject, month, etc. All desks are equipped with CRT terminals used to enter, edit, file, and retrieve information electronically.

Table 3. Automated Office System Components (McMurlin)

Information Generation	Information Distribution
Voice activated input devices	Distributed data networks
Multi-function intelligent work stations	Integrated communications (word/data/graphics/voice/image)
Two-way cable home television	Store and forward communications
Handwriting entry devices	Computer message systems
Graphical input devices	Smart facsimile devices (combined with OCR)
Word processing	Computerized branch exchanges (CBX)
Portable radio telephone	Micropublishing (computer typsetting from microforms)
'Intelligent' telephones with digitized voice	Intelligent copiers/printers
	Automatic typesetting
	Multi-media tele-conferencing
	Electronic bulletin boards
	OCR interfaces
	Electronic funds transfer systems (EFT)
Information Storage	**Information Query**
Electronic message files	'Personal assistant' services via software
Computer output microfilm and updatable microforms	Bibliographic search services
Multi-media digitized storage	Automated training techniques
Automated personal calendars	Interactive graphics
Automated information storage and retrieval systems	Data base management systems (DBMS)
Automatic message content indexing systems	Electronic pointers (light pen mouse)
	Specialized information services
	Simple English query/retrieval languages
	Decision support systems

Lieberman et al. (21) analyze the general office environment and its functions as in table 4.

Hammer (22) in an overview of office automation observes that despite the availability of such systems as ARPANET that today, office automation is virtually synonymous with word processing. After word processing, the most widely used function in office systems is records processing, which permits the maintenance and updating of files. Records processing permits the user to

Table 4. Elements of the Office and Administrative Environment (Lieberman)

Elements	Description
People	Levels and classification of personnel involved: managers (all levels), professionals, technicians (research assistants), secretaries, and clerks involved in the processes.
Processes	1. Creation - act of thinking and formulating a communication. 2. Capture - placing the communication on a medium (paper, terminal, tape recording) or conveying the message (via a telephone, at a conference). 3. Preparation - entry to, processing by, output from, a keyboard. 4. Revision - act of changing. 5. Distribution - message carrying, mail handling, electronic transmissions, traveling. 6. Expansion - copying (reprographics), printing, micrographics (microfilming). 7. Search, storage, and retrieval - indexing, storing, searching, information. 8. Disposal - discarding and purging of information.
Information	Encompasses the media and form of the information: voice, graphics (charts), images (pictures), data (numbers), text (narrative).
Technology	Involves the electronic, printing, and photographic technologies utilized in an office environment: typewriters, word processors, copiers, terminals, voice automation, computers, communications networks, printers, dictation equipment, photocomposition components, computer output and input microfilm, facsimile, offset printers, graphics, optical charter recognition (OCR), and others.
Plan/Direct/Organize	The basic managerial functions involved in establishing goals, objectives and strategies.
Coordinate/Control	Components of the basic managerial functions involved in the coordination of resources to ensure that objectives and action programs are achieved within certain guidelines.

select records which meet specified criteria and create documents using the basic data contained in files. Present systems are limited in processing several files simultaneously and impose severe restrictions on the size and number of records that can be managed.

Communication is central to the needs of the automated office and current technology offers many competing approaches. Communicating word processors and facsimile devices can improve document distribution, and electronic mail and message systems permit enhanced interpersonal communications. Few organizations have made commitments to either computer or voice mail as yet. Voice mail has the advantages of not requiring a keyboard, being usable from any touchtone telephone and requiring almost no training. However, it has the disadvantage of not being amenable to being searched and/or edited. Computer mail is most suitable for operational use, where written records can be edited, stored and retrieved.

While many individual technologies exist today (e.g., word processing, teleconferencing, micrographics, electronic mail systems, telecommunications), the future of office automation lies with the integration of these individual technologies into interdependent networks, according to Connell (11). Such networks are important because they will enable a broad range of technical advances to be brought to every office worker, regardless of location. This approach is opposite to the trend in the past to centralize computer applications into specialized departments, which were organizational entities and physically separated from the activities they were intended to support.

Networking takes place in three ways:

- ° Local networking - products of the same vendor communicate with each other in the same building or site.
- ° Remote networking - the same vendor products communicate with each other from site to site.
- ° Integrated networking - products of one vendor communicate with products of another vendor.

The phenomenon of integrated networks is also important because individual technologies must be subordinated to the needs of the network. These networks, to be effective, require an on-going coordinated planning effort which includes all office disiplines. This effort will substantially impact the organizational structure and operating practices of offices. The new technologies and networks permit managers to interact directly with information stored in a variety of locations and in countless forms, and be able to respond in a timely and effective manner. The ability to respond quickly to changing conditions may be the greatest contribution of modern office technologies to business effectiveness.

2.1 EVALUATION OF OFFICE AUTOMATION

In many instances where automation has been introduced into offices, the results have been very disappointing. The cause for this experience has often been a lack of sensitivity to human factors issues. Winegar (23) notes that employees are suspicious, especially when the word 'productivity' is mentioned. He stresses the need to seriously consider means of achieving job enrichment, as a means of offsetting the widespread concern by office worker that their tasks will be comprised of repetitive and routine operations, subordinated to the needs of computerized systems, and requiring a minimum of thought and initiative. Winegar points out that "job enrichment doesn't mean operating a machine like a production-line worker. It means freeing up time so office workers can spend it on more people-oriented, stimulating, and creative tasks in the office."

Strassman (17) indicates that the costs of implementing OA systems are largely unknown at present. He stresses the point that while data processing costs have been examined carefully by some organizations, administrative costs associated with office functioning have not received comparable attention, primarily because such costs are widely diffused and treated as overhead expenses, rarely aggregated under a single heading. In his view, these administrative information handling activities should be integrated as a major step toward increasing productivity. As a means of developing an appropriate system, the following steps are suggested by Strassman:

- Costs must be identified, not just computer and telecommunications costs, but budget elements of administrative processing and office labor.
- Determine detailed unit costs; e.g., purchase order, typed page.
- Establish standard costs as in a manufacturing assembly line.
- Decentralize responsibilities to permit middle level managers to make decisions about appropriate procedures.
- Use competitive pricing as a means of evaluating efficiency of internal information processing.
- Long term planning is needed - 2-5 year cycles rather than annual ones.

Strassman also observes that even when the costs of the knowledge worker can be quantified, the results achieved are elusive and not readily measureable in terms of product or profit. Surveys of large organizations have shown that the majority of the time spent by knowledge workers is in giving or receiving information; moreover, the bulk of this time is spent with people in the same organization. Electronic devices currently have limited capability in automating the non-standard and ever-changing communication patterns typical of knowledge workers.

Hammer (24) also cites the view the principal challenge to automation as the difficulty of measuring managerial and professional productivity as a means of cost-justifying office automation. Analyses of activities such as communicating, writing, and searching for information are thought to be irrelevant because they are not the most important components of their jobs. The most successful applications of office automation systems have been at the department level, to solve specific and well defined problems dealing with its business operations. Detailed planning for introducing strategies and developing the means to evaluate changes after introducing new systems are often overlooked. Hammer concludes that "A realistic appraisal of the capacities of the technology combined with an overriding concern for the firm's business goals and for the people in the organization will lead to an effective implementation of the office of the future - today."

Martin (12) suggests that the goal for office automation in the 1980s should be an improvement of productivity by effectively integrating the three major components of office automation - the people, the organization and the technology. The users should have a more important role in the planning and implementation process; the organization should place less emphasis on short-term goals; the technology should have improved usability and should include better user education as part of their marketing strategy. Martin notes that several barriers limit the usefulness of office automation today (table 5).

Table 5. Barriers to Successful Office Automation (Martin)

<u>Organizational</u>

- Dominated by short-term goals/earnings.
- Failure to understand the potential for improved operations.
- Failure to understand productivity/cost-benefits.
- Wants benefits without costs.

<u>People</u>

- Resist change.
- Want control.
- Don't understand what office automation requires them to do.

<u>Implementors</u>

- Unsure of user requirements.
- Seeking "ultimate" solutions.
- Lack planning expertise.
- Don't understand the anxiety of employees toward change.

<u>Technological</u>

- Number of choices.
- Incompatibility of technology.
- Incompatibility of media.
- Too few communication standards to permit standards integration.
- Questionable security.
- Changing user skills.
- Poor planning of physical space in the office.

Technological advances have provided the means to perform traditional office work in new ways; data and word processing exemplify the mechanization of such routine tasks. However, in recent years OA system designers and management theorists are focusing their attention on professional and managerial activities as offering the greatest potential for technology to increase organizational effectiveness. Many of these activities can be restructured to optimize the usefulness of computerized data bases and new communications systems by means of electric workstations. If future offices are to contain numerous workstations, often linked by networks to one another, and used by professional, managerial and support personnel, their design is likely to be quite different from that of the traditional office. The implications of the changed office work environment will be explored in the following chapters of the present report.

3. DESIGN

A necessary preliminary step in the development of criteria for automated offices is the evaluation of current offices which share many of the important features of automated offices. Studies of open-space office design provide most of the available information, although there is little evidence to suggest that traditional (private) offices or a mix of open and closed spaces will not be equally appropriate for automated offices.

Open space design was formulated with the view of the office as an information processing center. The planning was based on the assumption that a given office environment should be structured in accordance with the organizational processes that it contains. The geometry of a layout is intended to reflect the pattern of how individuals and groups work together. It was anticipated that this design would foster communication and enhance the cohesiveness of working groups, thereby improving productivity. Another feature of the design is to provide the flexibility to the individual for creating (and changing) the immediate environment - i.e., workspace.

While there is some research evidence that the open-space design has been successful in fostering group "togetherness", it's effects on increased productivity are unproven and questionable. In fact, several studies suggest that the open-plan design has resulted in many problems which are likely to adversely affect job performance.

3.1 STUDIES OF OFFICES

Rubin and Murray (25) conducted site visits at two large organizations with considerable experience in office automation - the Sheraton Corporations and Citicorp-Person-to-Person. The goal of these particular visits was to gain some insights regarding their experiences with planning and implementing OA for two diverse activities.

The Sheraton Corporation has a paperless office to carry out one major purpose - to book hotel reservations from travel agents (26). The office was designed for maximum effectiveness, with a centralized computer system containing information about room availability everywhere in the world.

Among the management concerns for planning this center were the following:

(1) A highly computerized telephone switching system that could be used to keep track of each employee's calls, and provide a method of measuring and managing the operation.

(2) A convenient remote access to the Sheraton reservation central computer system in Boston.

(3) A direct interface with each of the travel agents using the system.

(4) An open space office plan, designed to give the operators acoustical and visual privacy when seated, and a flexible and modular based system to allow for future expansion or relocation.

(5) A floor plan with enough flexibility to accommodate more than twice the number of operators required when the center was to open - 96 initially, with expansion capability for 250.

(6) A backup system consisting of an array of batteries, providing uninterrupted power in case of a power failure.

The orientation of the center is to balance the needs of the employees for a pleasant work environment with the requirement to ensure the quality and responsiveness of the work performed by the staff. Considerable time and effort has been expended to accommodate the personal needs of the workforce, while at the same time equal efforts have been expended on the development of a Management Information System (MIS), and a monitoring capability designed to ensure the effectiveness of the reservation system.

The site was carefully selected to ensure a pleasant visual surround, access to parking and restaurants and in a relatively secluded location. Employee lounge areas with couches are provided, as well as informal dining areas for eating lunch or conducting conversations. A dedicated room is available for the training of new staff members, and refresher courses for experienced personnel. Hotel managers promoting various vacation "packages" are invited to talk to the staff as a means of ensuring that they are kept current with the institutional advertising. These meetings, held in the training room, have the added advantage of enriching the overall work environment of the operators by introducing some variety into their work day. The management also encourages the operators to read or otherwise amuse themselves during the times when they are not actually at the terminal making reservation.

The work floor follows an open space plan, with the walls, floors and ceilings being acoustically "treated". The overall environment is one which is quiet and comfortable. The color scheme is quite subdued, with workstations separated by partitions 4 feet in height, to enable individuals to see and talk to one another when standing. Each light fixture has three parabolic lenses to minimize possible glare onto the CRT screen. The layout is such that at most workstations, there is a view to the outside to provide some visual relief. Each workstation has a minimum of 72 square feet, which contains a chair, and a table with a video display screen and a keyboard. No filing cabinet is available and there is no requirement for any traditional paper work - it is essentially an electronic work station. Direct circuits are leased from a multitude of vendors and "fed" through the local phone company into an automatic call distribution system. This system provides a constant log of calls, enabling calls to be automatically routed through each operator position. It also provides a constant monitoring of all phone calls and a record of the troubles that occur within the circuit. This telephone monitoring and call distribution system has provided management with the information required concerning the times that their circuits are operating. Thus, management can be certain that it is obtaining maximum utilization and distribution of call load across the entire system as it being fed to their operator positions. A technician is on duty during the prime time of the operation of the center and is on call after duty hours. The computer and the telephone systems are provided with backup power in the event of a power failure.

Citicorp Person-to-Person, which specializes in first and second mortgages for homeowners provides a different approach to office automation design. In contrast to the single purpose needs of the Sheraton Corporation in its reservation center, this operation is characterized by the need to respond to frequent changes (27). The stated goal of the company is to provide the most modern office technology to assist staff to do their jobs effectively in a pleasant environment, while allowing management the flexibility for expansion which has characterized the organization to date.

When this activity was initiated, the management of the organization was highly centralized, with most decisions being made at the headquarters in St. Louis. At present, the headquarters performs mainly a monitoring function and central staff functions such as accounting, personnel and data processing. Operational activities are now decentralized to seven regional offices.

In designing a new facility for its operations, Citicorp-Person-to-Person planned for future expansion by leasing 52,000 sq. ft. in a new development with the option of purchasing the entire building after 10 years, if required. In the design of the facilities, aesthetics were not considered to be a frill, but an essential ingredient for a good work place, thought to be conducive for high morale and work effectiveness. The exterior and interior environments of the building were both thought to be important considerations. For example, the site was chosen as providing a pleasant setting for work, and for presenting an interesting view from the interior of the building.

While one design goal was to provide the most advanced technology available for the workforce, the layout and design of the interior spaces and workstations received a great deal of attention. Lighting, sound conditioning, and the general appearance of the building interior were carefully planned. Considerable thought went into the organization of working groups within an open-plan concept as well; for example, to provide the opportunity for social interaction among individuals working on different but related tasks.

A major consideration in the design was to provide response to a fast-changing environment. The building was not equipped with a floor-duct electrical system, and consequently this became the first building in Missouri to use flatwire cable for bringing power to work stations. This necessity became a virtue because management determined that it was cost effective over the long term, although representing a greater initial investment. The benefits include enormous flexibility and ease of rewiring, eliminating the need for power poles, and compatibility with the carpet tiles used throughout the facility. The wire is virtually imperceptible beneath the carpet tiles. As a result of this system, approximately 100 people can be relocated over a weekend with very little difficulty, in new office space equipped with new telephones and work station facilities. Moving the phones consists of plugging into a new grid modular plug and reprogramming the number and location into the main switch.

3.1.1 Interior Layout and Design of Citicorp Person-to-Person

Each corporate level vice president has approximately 200 square feet of hard wall office on the perimeter of each floor. All other management and working level people share an open-plan office environment. Panels which separate workstations from one another vary in height from 75 inches to 53 inches, depending upon the status of the individual within the organization, with the managers provided with the highest panels. Seven standard, but differently sized workstations are assigned according to job rank and functional requirements. The workstations with the tallest partitions occupy the center of the floor, with the shorter ones sloping downward toward the windows. This design places the clerical and secretarial staff at the windows and allows everyone to enjoy the view, and also permits the enhanced use of natural light. An added advantage is that the tall partitions form a corridor that separates departments from one another, creating a sense of community for each section.

The open-space was designed to allow ready transit by supervisors and others. This design was utilized to prevent the employees from having a sense of isolation and detachment from the mainstream of activities taking place in the office. Individuals are free to move from their workstations around the floor to meet other people doing similar or related jobs.

The employees have the opportunity to select from two types of designer furniture for their workstations. Top management selected furniture from other manufacturers to avoid expressing a preference for either "standard". Individualization of workstations was encouraged, i.e., personal items such as photographs. A name plate identifies the occupant of the particular workstation. As noted earlier, the floor area was constructed of acoustically soft carpet tiles, having accent colors. The tile colors, offered another possibility for individual expression and opportunity by the employee to select from a range of possible choices to be used in a given work area.

Each building level contains a service center, which is centrally located. It provides free coffee to employees and access to equipment such as copying machines. Also available on each floor are two conference centers, one large and one small, to accommodate meetings and provide a place for private conversations. (Unfortunately, the rooms adjoin one another and do not have appropriate acoustical separation, and consequently privacy is compromised and the activities performed in one room interfere with those in the adjoining one.)

3.1.2 Technological Issues

- The information processing capability consists of a data processing center and a local area network that provides support to professional workstations, and a centralized word processing center providing administrative support for all activities. The data processing center is used for such activities as billing information, permanent file retention of transactions, accounting and financial information and designated management information. The individual microprocessors are used for correspondence, local calculations and inter-office communications among specified elements within the organization.

- All word processing equipment and local area network equipment, comprised of approximately 25 to 50 word processing terminals with a shared logic system, are integrated into the basic phone system by utilizing a fully digital switch. The two wire pair not only provides concurrent telephone operations but also the basic background support for all the local area networks. The communications facilities that support the phone system utilizes several services from several vendors. This approach allows the PBX system to employ least-cost routing of all of the company's long distance calls. Although the immediate demand for digital telephone system capability was not readily apparent, management felt that it was a good investment since their demand for data type communications was likely to grow over the next five years.

- An uninterruptable power supply with standby batteries and generator protect the basic computer center and the local area office network from basic system failure during critical support times.

- Most of the field offices have a choice of the technology that they use, determined by whatever solution is most cost-effective. As a result, these offices contain a variety of telephone switches and terminal equipment. Equipment is obtained from local Bell operating companies or any of the various interconnect vendors.

- At present, a teleconferencing capability is being planned to provide services among the local, regional and central offices.

3.1.3 Issues Identified by Research

Brookes and Kaplan (28) reviewed studies of open-office environments and concluded that the loss of privacy and intrusions of noise into the workplace posed major difficulties for the people working in these environments. They also indicated that there was no evidence to suggest that employees were given the opportunity to modify their workplaces to suit their individual needs and tastes; rather, workplace design and layout was apparently controlled by organizational policy. Nemecek and Grandjean (29) performed a questionnaire survey of open-space offices and obtained findings which confirmed those of Brookes and Kaplan. They found that in addition to noise and privacy being problem areas, that almost 25 percent of the workforce complained about lighting conditions. Depsite these difficulties with open-space design, the authors conclude that the advantages of such a plan outweighed the disadvantages.

Hedge (30) in another questionnaire survey of office employees, wanted to determine their general reactions to open-space planning, and whether job-related factors contributed to their assessments. He found that loss of privacy and work disturbances attributed to unwanted interruptions were the major problem areas. The staff members with the most complex and demanding jobs appeared to be more sensitive to environmental conditions and expressed a greater degree of dissatisfaction with them than the workers doing more routine tasks. Another observation made by Hedge is that although the open-space plan was selected because of its flexibility, there were few individual or organizational changes of the working environment during the course of occupancy. The author theorizes that after the initial move-in period, the design features selected because of their inherent flexibility are nonetheless perceived by the staff and the organization as being "fixed", consistent with their past experiences.

A national survey was conducted among design professionals, company executives and office workers by Harris (31, 32) to determine their attitudes toward features of present and future offices. Among the major study conclusions are:

° Nearly all office workers believed that their job performance and personal satisfaction are influenced by their job surroundings.

° While workers indicated that the need for personal privacy is a very important one, designers and executives equated this need with executive work, not general office work. The same dichotomy of viewpoints characterized the desire of office workers to be directly involved in planning their work spaces.

° Inadequate temperature control and poor air circulation were identified as major complaints by office workers. Other factors mentioned was the desire for more space, and a place to work when there was a need to concentrate without distractions. Noise was said to be a major problem by a sizable minority of respondents.

° Most of the workers pointed to the need for good lighting as an essential characteristic of an effective office environment.

° Almost half of the respondents indicated that a comfortable chair, with good back support, would contribute to their productivity.

Brill et al. (33) described the major findings of a questionnaire survey of more than 4000 office workers employed in 50 offices. The major finding of the study was that: "Changes in productivity and quality of work life are caused by changes in the design of specific aspects of the office, and by overall satisfaction with changes in that environment." Table 6 summarizes the factors impacting the major attributes of the jobs that were examined:

Table 6. Factors Influencing Job Satisfaction, Performance, Communication (Brill)

Job Performance and/or Job Satisfaction

- Amount of floor area in personal work space
- Temperature and air quality
- Lighting at the work station
- Sense of safety and security
- Control over physical access by others to your work space
- How many people you see and who see you in your work space
- Noise
- Ease and quality of communication with others
- Comfort in the work space
- Frequency of relocation of workers
- Quality of maintenance
- Participation in the design decision process

Ease and Quality of Communication and Interaction with Others

- Degree of enclosure (number and height of walls, panels, etc.)
- Layout of the office
- Speech privacy
- Status, as reflected in physical environment

Quinan (34) in a study of the use of systems furniture identified several problem areas among the federal office workers questioned:

- Loss of speech privacy was the most frequent complaint mentioned.

- The open-office plan has increased the need for small conference spaces to conduct meetings.

- Many people expressed the desire to have visual access to the outside by means of windows.

- The available furniture systems did not accommodate all of the space and storage needs of the staff, e.g., more file space needed.

- The open-plan often makes it difficult for people to find their way to proposed destinations. Appropriate signage and graphics systems are essential to facilitate "pathfinding"; this is especially true for organizations which have many visitors.

Table 7 describes the issues which affected job satisfaction and performance, as well as satisfaction with the environment. Job performance ratings were made by individuals and by supervisors.

Table 7. Summary of Findings of Questionnaire Survey (Quinan, et al.)

Issue	Bottom-Line Measures			
	Environment Satisfaction	Job Satisfaction	Job Performance (Self)	Job Performance (Supervisor)
FURNITURE				
Layout	X*			
Comfort	X	X		
Furniture Quality	X		X	
AMBIENT CONDITIONS				
Temperature/Air Quality				
Lighting	X			
Noise		X		
PRIVACY				
Control Over Access	X			X
Intrusions/Distractions	X			
Speech Privacy	X			
Visual Access			X	
COMMUNICATIONS				
Ease of Communication	X	X		
Support for Communication	X			
FLEXIBILITY	X	X		

* Issues affecting job satisfaction.

Pile (35) summarized the advantages of open system planning as compared with the traditional approach by noting that open offices provide easy flexibility to take account of organizational changes. It offers improved communications through convenient visual contact. Each workstation can be individually tailored for a specific person and/or task. Task lighting can be readily supplied. Finally, a sense of openness and informality associated with open space design can be aesthetically pleasing.

Several problem areas were also identified by Pile. One of the major ones is the lack of privacy - acoustic and visual. Open-space designs are difficult to plan initially, and pose difficulties when it is necessary to modify existing design. The need to store "spare parts" (e.g., modules, furniture, panels, etc.) is both costly and requires additional storage space. The location of available wiring connections when changes are being made is often a costly and time-consuming activity.

3.2 PLANNING APPROACHES TO OFFICE DESIGN

Quinan (34) describes an "ideal" process to implement integrated furniture systems. The first step is to perform a diagnostic study and analysis of the current environment to determine whether any changes are required. Organizational, personal and environmental issues are examined. Then space needs which meet the functional requirements of the organization and the staff are determined, as well as the personal satisfaction needs of the workers. Design alternatives are then examined, with tenant agencies participating actively in the decision making process. The move-in activity should be facilitated by providing assistance in using the new environment and equipment. An owner's manual should be developed and distributed to all tenant agencies to facilitate the proper use of the facilities and systems. A post-occupancy evaluation is advocated to determine the effectiveness of the designed space, and to establish whether the problems identified earlier had been solved by the new design. Finally, the building should be monitored annually by means of "mini" post-occupancy studies, to ensure that physical and organizational changes do not degrade the performance of the building.

Brill, et al. (36), in a study performed for Hauserman, Inc. identified many of the subject areas which merit attention in the development of performance requirements for offices. They cited the following major considerations:

- "Provide COMFORT
- Allow PERSONALIZATION
- Provide TASK SUPPORT
- Furnish STORAGE
- Insure appropriate SECURITY
- Facilitate appropriate levels of PRIVACY
- Facilitate COMMUNICATIONS
- Accommodate VISITORS
- Be SAFE
- Provide STABILITY and STRENGTH
- Be DURABLE
- Facilitate POWER distribution

- Facilitate appropriate ILLUMINATION and ILLUMINATION CONTROL
- Facilitate appropriate ACOUSTIC CONTROL
- Facilitate appropriate HVAC CONTROL
- Facilitate WASTE MANAGEMENT
- Be easily MAINTAINABLE
- Permit USER EXPERIMENTATION
- Provide appropriate INFORMATION ABOUT ITS USE & MODIFICATION
- Be AESTHETICALLY SATISFYING
- Be efficiently STORABLE when not in use"

The authors conclude that these requirements must be met on at least four levels. The design of: 1) components, 2) individual work places, 3) clusters of individual work places, and 4) office floors.

Lozar and Porter (37) use the term 'habitability' to describe the impact of the environment on the behavior of building users with respect to their welfare, task performance, and job satisfaction. They describe the development and testing of a research approach intended to better understand the relationship between design and the activities, behaviors and experiences of building occupants. Among their goals was to determine: how the occupant relies on the environment to provide information; ways in which the occupant can control the environment and surroundings; how the environment is used to fulfill needs for social interaction and stimulation, and a sense of private space (territoriality). In examining these issues a questionnaire survey covering a broad range of issues was administered. Table 8 lists the many individual needs examined in the survey.

Brauer et al. (38) were also concerned with developing design information from the standpoint of habitability. The process consists of six phases:

1. Defining goals, requirement, constraints and background data.

2. Collecting and organizing reference materials.

3. Preparing an initial draft of design data.

4. Updating the draft document - identifying gaps and filling them.

5. Developing supporting procedures to assist user in the application of habitability data.

6. Final document preparation. Substantive and procedural information is organized and formatted for publication.

The Veterans Administration has designed a proposed computerized system which is intended to integrate six major functions of the projects performed by their office of construction (39). The system will cover: Design Criteria, A/E

Table 8. Occupant Needs for Welfare, Task Performance, Satisfaction (Lozar & Porter)

Optimum Occupant Welfare

- Climate - air change, temperature, humidity
- Avoidance of odor
- Avoidance of eye fatigue due to glare, light-dark contrasts
- Avoidance of noise disturbances from external and internal sources
- Avoidance of danger-safety rules
- Easy maintenance
- Consideration of cleanliness requirements of user groups
- Avoidance of emissions from polluting sources

Optimum Task Performance - Function

- Adequate space area and volume
- Adequate amount of equipment and furnishings
- Ergonomically suitable equipment and funishings

Optimum Occupant Satisfaction

- Sociable - enabling or inhibiting social interaction
- Privacy - sharing of space based on visual, acoustical and physical relationships
- Choice - degree of allowing co-existing behaviors. Accommodating extensive individual expression
- Comfort - degree of spatial, acoustical and visual "fit"
- Clarity - degree to which space is identifiable with purpose
- Efficiency - enabling desired activities to be performed
- Adaptability
- Formality - degree to which activities are structured by space
- Territoriality - allowing individual control of space
- Activity - extent to which dynamic activities can be performed
- Image - aesthetic expression of the functions of the facility

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Package Production, Design Drawing Review, Area Reports for in-house and A/E use, and Design Proposals. Figure 2 provides an overview diagram of the system.

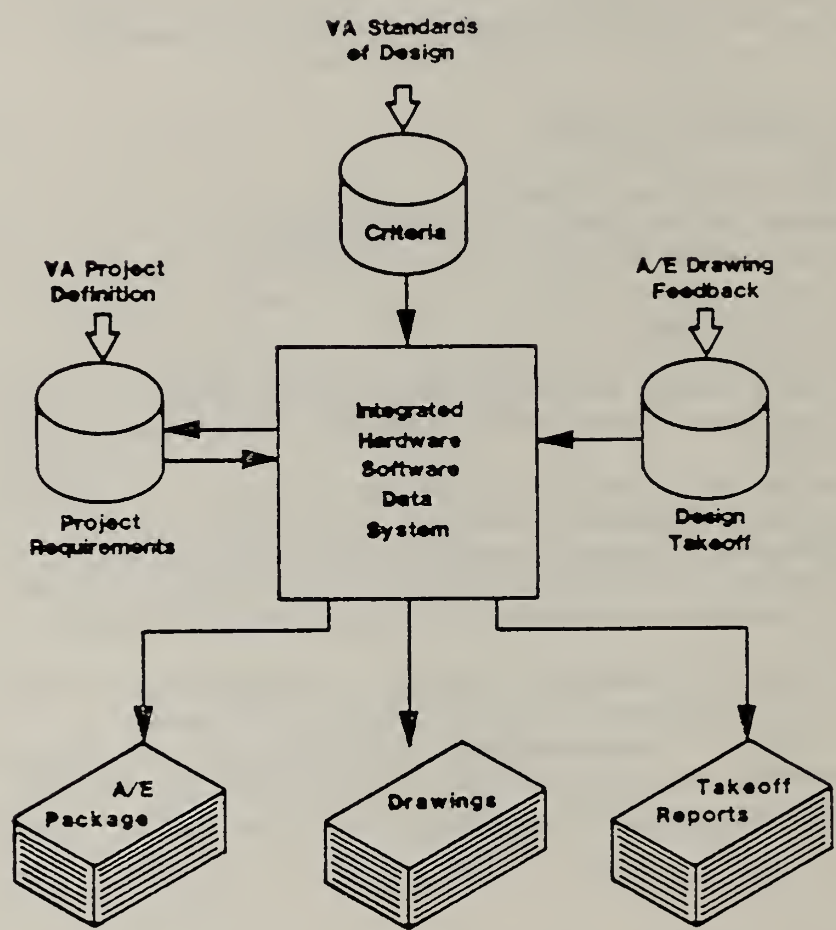


Figure 2. Overview diagram facility development, design & review system (Veterans Administration)

Marans and Spreckelmeyer (40) developed and tested a conceptual model for evaluating office environments. The model is intended to help understand the interrelationships of evaluative data concerned with the actions and feelings of workers and environmental features. It can also serve as an organizational framework to collect and analyze building evaluation findings. Job satisfaction and work performance are posited as the appropriate behaviorial characteristics to be measured in such evaluations. Figure 3 illustrates the model formulated by the authors.

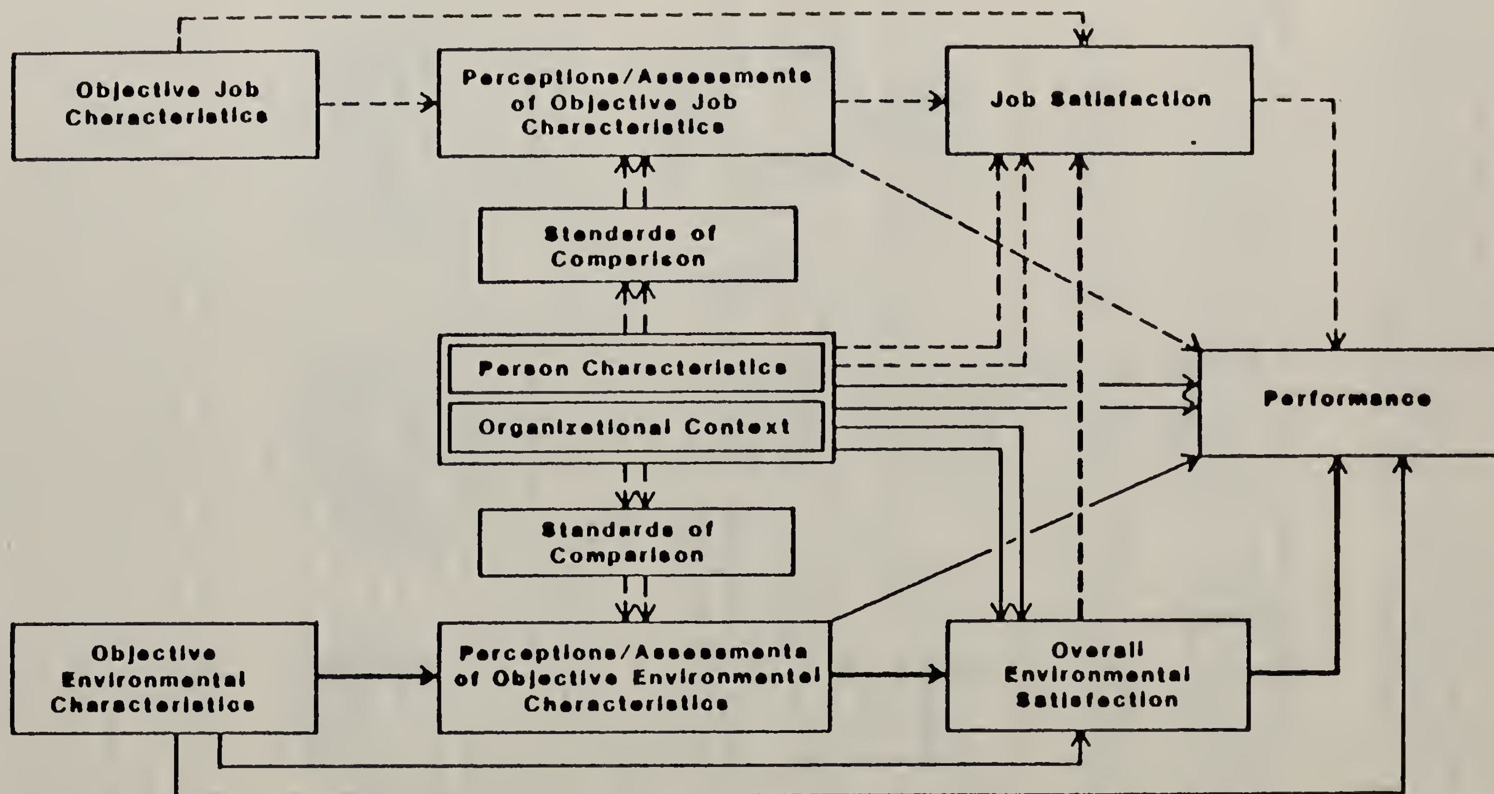
In testing the model, researchers administered a questionnaire to employees of federal offices. Some of the workers were housed in traditional offices, while others occupied open-space settings. The reactions of the two groups of employees were compared. The major findings were as follows:

- Occupants of traditional offices expressed greater satisfaction with their environment than their colleagues in open-space offices.
- Conversational and visual privacy were major problem areas for the open space occupants.
- People having control of their individual environment expressed greater satisfaction with their workplace than those having little control.
- The general assessment of the larger setting (e.g., the building) was substantially influenced by the feelings about the individual workplace.
- The amount of workspace available was the single most important indicator of satisfaction with the workplace.

3.3 ENVIRONMENTAL SYSTEMS

In user surveys of open-office designs, and of video display terminal usage in offices, two major problem areas have been identified - acoustics and lighting. The acoustic environment has posed difficulties with respect to the need for speech privacy. Confidential discussions play an important role in many of the activities performed in offices. Within an organization a need frequently exists for colleagues to discuss personal and/or work related activities without being concerned about being overheard by third parties. Similarly, the general public is often served by private and public organizations in open-office environments. The subjects of many such discussions are highly personal and confidential, and should not be in danger of being compromised.

Another problem area associated with the acoustic environment is the lack of effective noise isolation from noise producing equipment such as electric typewriters and printers. Unlike the situation in a private office where such noises are largely confined to a specific work area, in the open-office design situation these noises frequently intrude to many work areas where individuals require a quiet environment to engage in analytical activities. Noise has a detrimental effect on the ability to concentrate on the job at hand, especially so for management and professional personnel.



Note: Bold 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.

Figure 3. Conceptual model for evaluating work environments (Marans)

The other office environmental issue which has received considerable attention is lighting. The introduction of video display terminals in increasing numbers has posed problems for lighting designers, who must now provide an environment which accommodates both paper tasks and activities centered on an electronic terminal. A major problem is the prevention of glare on the surface of the video screen, by daylight or artificial illumination. Individual control of lighting is an important factor as is the mix of task and ambient lighting.

3.3.1 Acoustics

As noted previously, in the open-office environment, the major acoustic issues identified by researchers and designers are those of noise and privacy. Montone (41) provides a general overview of noise related acoustical concerns as they impact the design of building interiors. He noted that the acoustical properties of spaces are influenced by such factors as the thickness and density of structural membranes, the porosity of wall and floor covers, insulation, drapes and furnishings. Sound is affected by room shape, volume, and the characteristics of the interior surfaces. The surface treatment of the space is considered to be the single most important determinant of the acoustical properties of the space. The sound absorbing qualities of the surface treatments are characterized by their sound absorption properties. The sound absorption coefficient is a measure of the amount of sound absorbed by a surface. Hard materials (e.g., concrete, metals) have very low values, with carpeting having a higher relative value (the scale ranges from 0 to 1.0).

Four basic methods are used to reduce unwanted sound intrusions (noise):

(1) Sound barriers reduce or eliminate noise by reflecting it or resisting its transmission. The mass of the material used as a barrier determines its effectiveness. Typical barriers in buildings are sheet rock, gypsum board, concrete, brick or wood. Sound Transmission Class (STC) ratings are employed to describe the effectiveness of partitions from an acoustical standpoint.

(2) Sound absorption employs porous materials to absorb or dissipate acoustical energy. Materials used for this purpose are fiberglas insulation, open foam insulation and cloth. This approach is concerned with the control of noise within a space, but is not effective in preventing sound transmission to adjoining location.

(3) Vibration damping treatment prevents a material from resonating to a primary noise source, thereby acting as a secondary noise source. Windows, walls and machine components are potential problem areas. Rubber or vinyl is typically laminated to the surface of the noise-producing element, to prevent this problem from occurring.

(4) Vibration isolation is a means of preventing vibrations from one space being transmitted to an adjoining one. This is usually accomplished by means of rubber, compressed fiberglass or springs. (An example of this approach is the placement of a rubber mat between a typewriter or printer and a desk surface.)

(Berendt, Corliss and Ojalvo (42) provide a detailed description of the procedures available for noise control in buildings.)

In a discussion of privacy requirements for open-office designs, Walker (43, 44) deals with some of the major issues in office acoustics. He first makes a distinction between two kinds of privacy - normal and confidential. Normal privacy is defined as a condition where speech from adjacent locations can be understood if one listened intently, but the speech is not loud enough to cause disturbance. Confidential privacy requirements would preclude the understanding of phrases and/or sentences in adjoining locations and is therefore a much more stringent condition.

Walker indicates that the Articulation Index (AI) is the preferred method of assessing speech privacy. It is a measure of the percentages of sentences that can be understood from a person speaking in a normal conversational tone. The index is based upon the signal-to-noise (S/N) differences in decibels (dB), weighted in terms of the relative contribution of each one-third octave band to speech intelligibility. As the speech signal drops toward the noise level, the AI value approaches zero; as the speech level rises above the noise, the AI value nears 1.0. (See figure 4.)

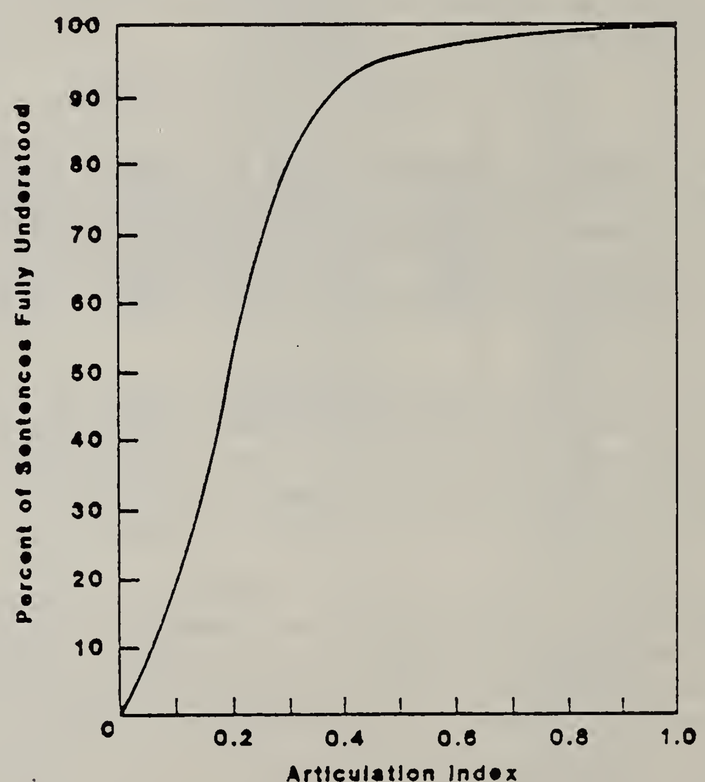


Figure 4. Approximate relation between AI and speech intelligibility (Walker)

Another technique for specifying the desired acoustical properties of spaces in the use of Noise Criterion (NC) Curves. ((Yaniv and Flynn (45) provide a critical overview of other noise criteria that have been used for building design.)) The NC curves were developed by Beranek (46), based upon opinion surveys of office workers. Questionnaire survey responses were correlated with physical acoustical measurements in specifying the acoustical properties of spaces for the performance of given activities. Figure 5 illustrates the characteristics of a set of NC curves.

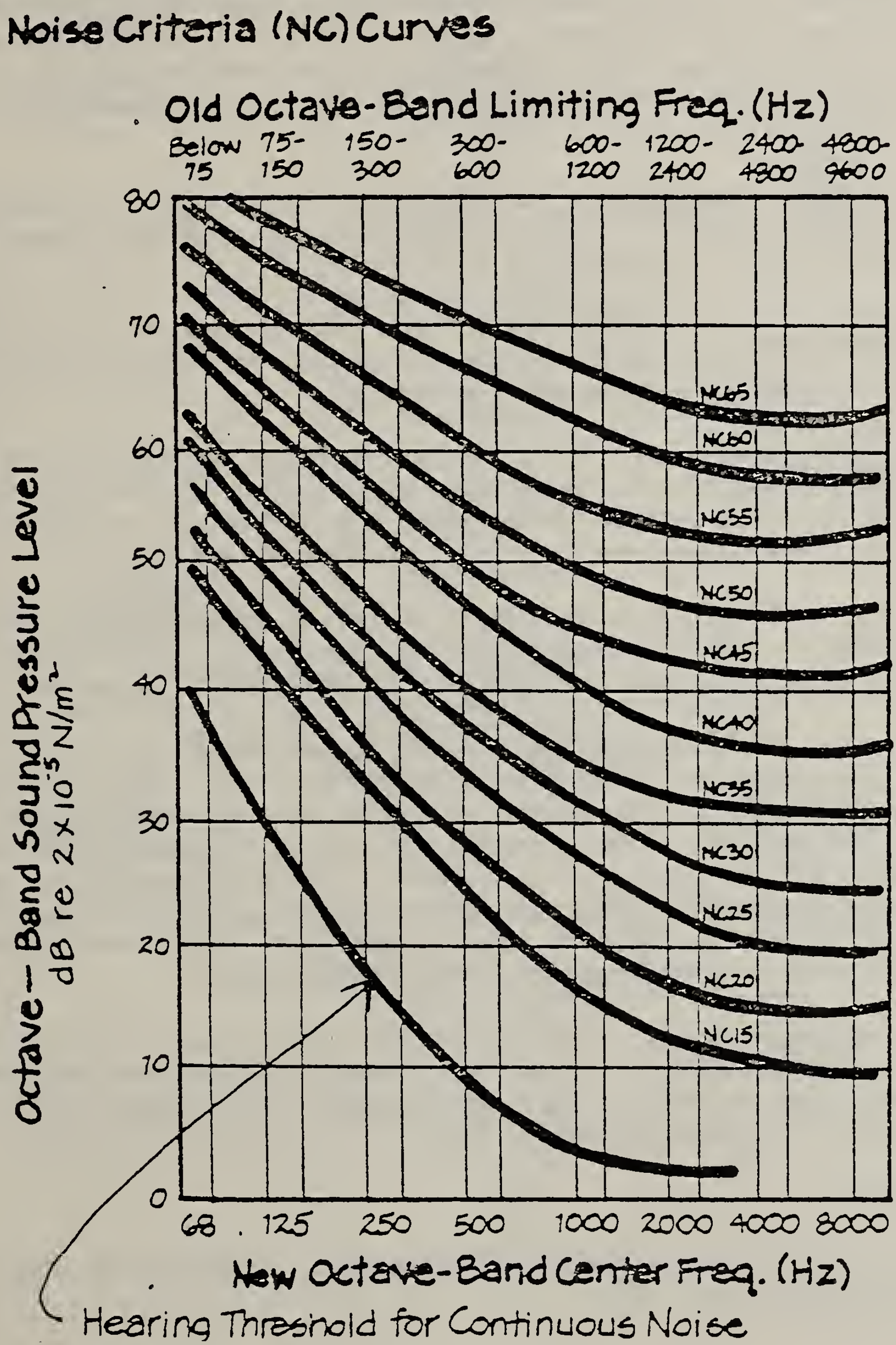


Figure 5. Noise criteria (NC) curves (Beranek)

Probst and Wodka (47) describe their acoustic approach for the Action Office by first citing their major objectives: being able to accommodate normal conversation; maintaining privacy within a radius of 10-15 feet between speakers, and to provide acoustic environments appropriate for their performance of particular activities. The following are among the design issues which merit particular attention:

(1) Ceilings. Those 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 are encountered. The authors note that: "Ideally, a flat ceiling in Action Office equipped spaces should absorb from 90 to 95 percent of the sound reaching it."

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

(3) Configuration. 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.

(4) Masking sound. At times, the introduction of electrically generated sound is needed to provide comfort or privacy. The authors stress the need for such systems to be under the control of the user for maximum effectiveness.

(5) Floors. 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.

Hirtle and Powers (48) developed a system (OPLAN) which employs a computer program for the acoustical design of open-plan offices. The system is intended to provide an estimate of the degree of speech privacy anticipated for each of the workstations analyzed. The program takes into account all paths by which sound travels from one location to another. "The program user is asked to input anticipated speech effort, source/receiver distance, screen locations and dimensions, materials, background noise levels, and the degree of privacy required." Figure 6 summarizes the approach developed.

Walker (43) in a discussion of the components to be considered for the acoustical design of offices, notes that overall performance will be equivalent to the weakest link in the system, and therefore all elements must be considered as they interact with one another.

3.3.2 Lighting

With respect to the general lighting conditions, the following observations were made by Brown et al. (49):

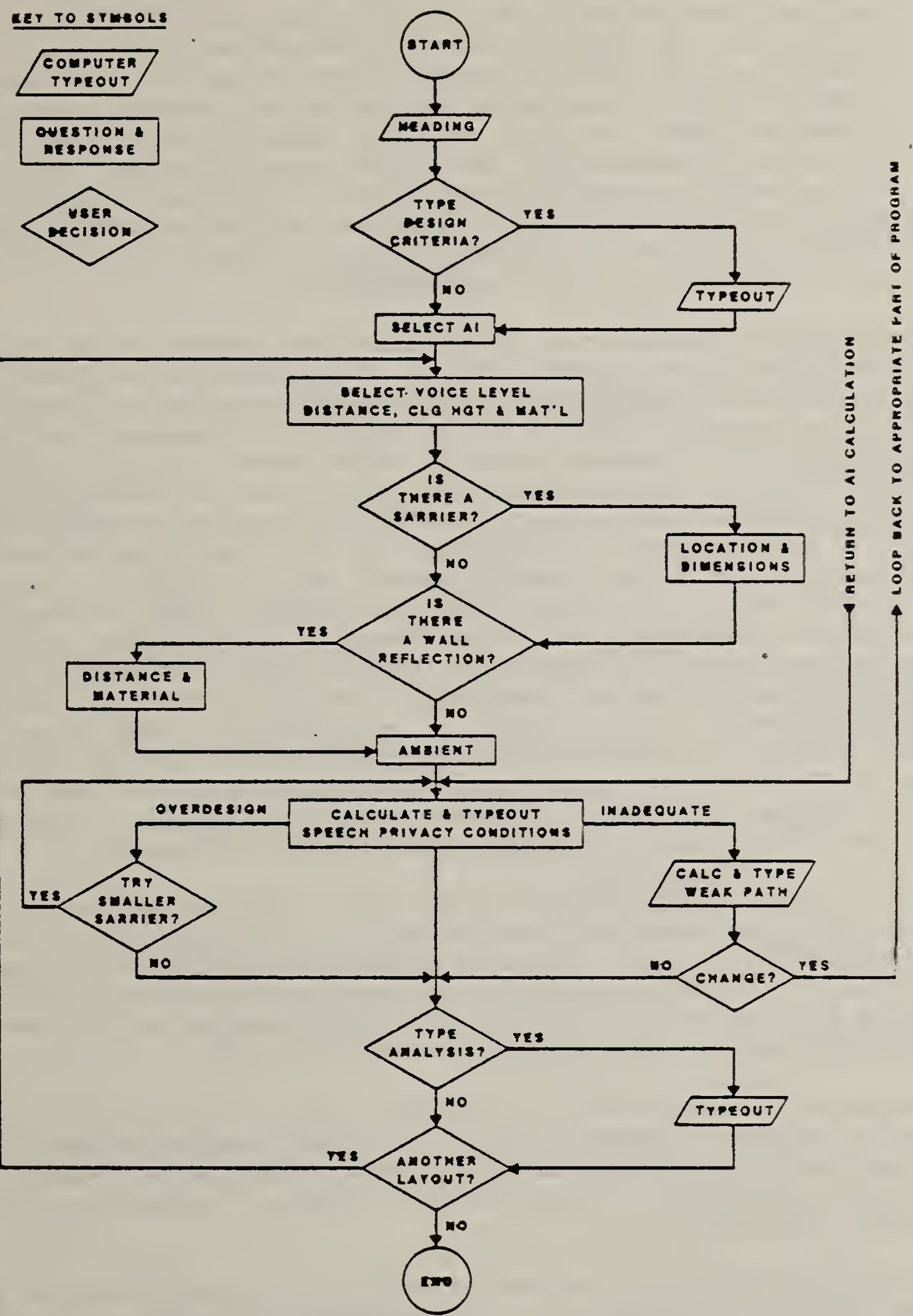


Figure 6. Simplified block diagram of OPLAN program (Hirtle and Powers)

> "A properly designed lighted environment that may be comfortable for office workers performing traditional desk-top work may not be comfortable for workers performing VDT tasks. 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° 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 surfaces of the VDT and ceiling reflections reduce the visibility of the display by reducing the physical contrast between the characters and the screen background."

Christensen (50) observes that fluorescent type luminaires are generally used in offices where video display terminal VDT displays are employed. The primary design consideration for lighting in these situations is to eliminate reflections of the lamp from the face of the tube. He recommends that this be accomplished by using a "specular parabolic wedge louver," since it has a cutoff of 45°, which is below the normal viewing angle. The characteristics of the surrounding environment must also be carefully controlled to ensure the visual comfort of VDT operators. He suggests that walls and other sufaces should have reflectance values of less than 50 percent, to accomplish this goal. Keating (51) further notes that all desk and work surfaces should be comprised of matte, or low glare non-reflective surfaces, and should have medium tone colors. They should not be black or white, or exhibit sharp contrasts in color or relective surfaces in order to minimize "visual irritation". Another consideration is to position VDT's so they are not parallel to each other. This approach avoids the possibility of the light from the screens reflecting on each other. A final test to ensure that the major problems have been eliminated is to move a mirror along the front surface of the VDT screen. This procedure will reveal bright sources to light that should be attended to.

Keating advocates indirect lighting for VDT's, with the source being mounted below the ceiling, suspended from the ceiling, or placed in a kiosk. In all of these approaches the light should be directed toward the ceiling, which acts as a reflector. "The major point is that light rays are directed laterally, resulting in shadow-free lighting and the light source being hidden from view, and therefore being eliminated as a possible irritant."

Lautzenheiser (52) observes that with the advent of open offices lighting design has become an integral part of the overall design decision process, affecting factors such as acoustics and power distribution systems. As a means of clarifying the design choices made for lighting, he developed a decision tree model (figure 7).

The most basic decision to be made is whether the system should be a task/ambient or an ambient one. In the task/ambient approach, task lighting is treated sepatately from the general surround (ambient), which is usually at

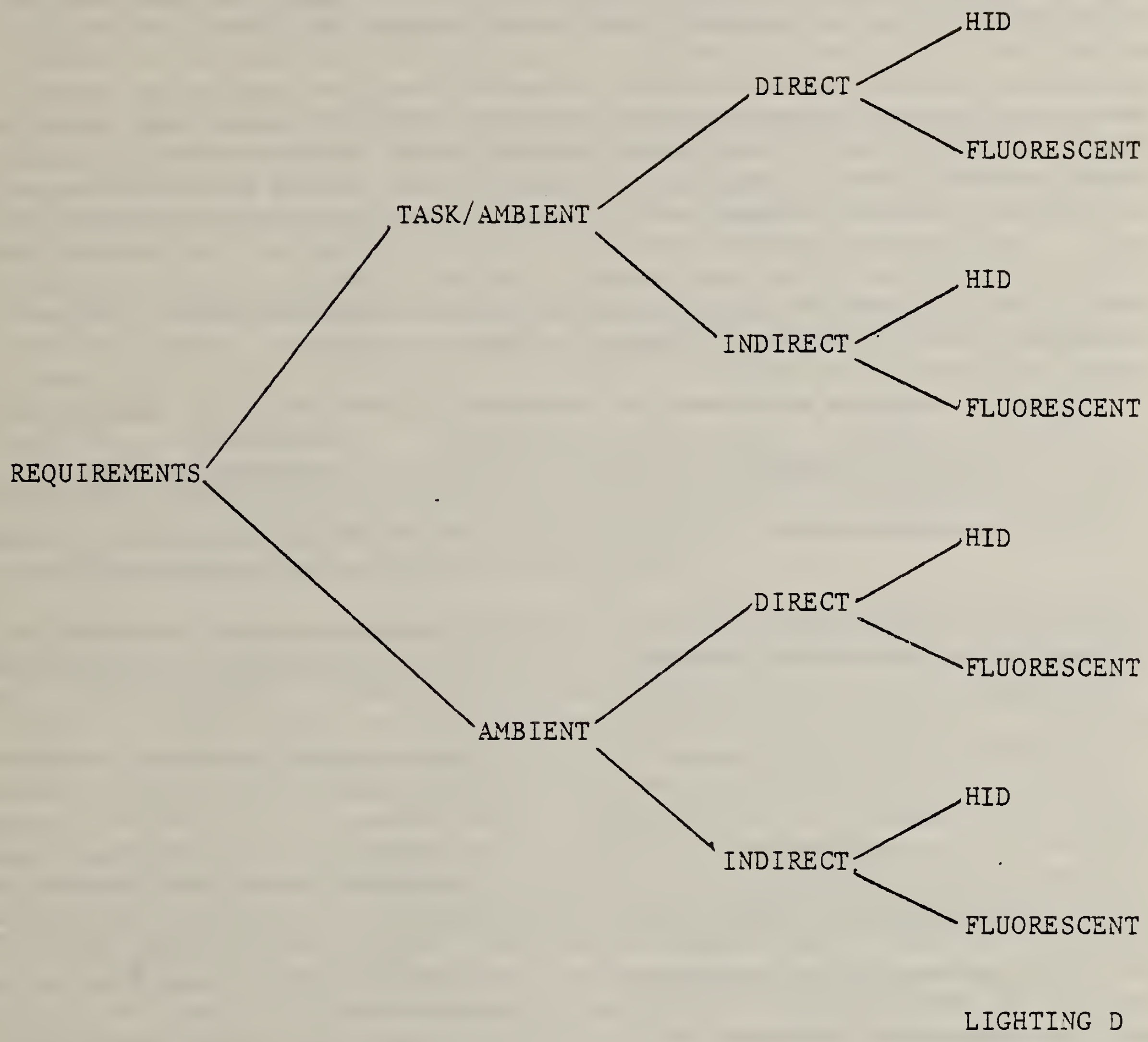


Figure 7. Decision tree of lighting decisions (Lautzenheiser)

a lower level. The task location must be known in advance to ensure the ade- the planning density of the space, and the particular needs of workstations which might house different tasks. Power use can be quite variable because the lighting is typically controlled by the user. The overall space may present a non-uniform appearance because of the lack of a standardized lighting scheme. The 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.

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 do 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. Table 9 summarizes some of the major features of each approach.

Table 9. Features of Direct and Indirect Lighting Systems (Lautzenheiser)

Direct Systems	Indirect Systems
° High lumen efficiency	° Lumen efficiency lowered by ceiling reflectance (usually 80%)
° Increased energy efficiency- heat can be vented and treated separately	° Power system must accommodate a large number of 120 volt circuits
° Shadowing must be controlled	° Fewer shadow problems; light source is ceiling
° Possible source of glare	° Luminaire is not visible; little chance of glare from source.

The final system element considered by Lautzenheiser in his model is the light source. He observes that the two major sources used in offices are fluorescent and high intensity discharge (HID). The HID lamps are high in energy efficiency but are said to present a number of difficulties: high light reduction over the life of the lamp (up to 50 percent); a limited number of colors are available; there are sometimes problems with color stability and the standardization of particular colors. The author notes that fluorescent lamps are more readily available than HID sources, their color consistency is high, and lumen maintenance is good (deterioration about 20 percent) (This paper was written in 1981, and the preceding evaluation may not represent the present state-of-the-art of HID lamps.)

3.3.3 Power Distribution Systems

One of the major design considerations in providing the required flexibility to the automated office is the treatment of electrical systems. This subject was introduced in an Architectural Record article (53) as follows:

> "For many years wiring systems remained basically the same because offices remained the same. But manufacturers now offer new arrays of systems designed to provide more flexibility in delivering power and communications to work areas; greater flexibility in running wires to, and in switching lighting fixtures; and greater capacities and security for communications wiring. The impetus for these changes stem from: 1) the growth of the open plan; 2) the advent of the electronic office; 3) energy conservation; and 4) labor savings in running wiring and connecting it to lights and outlets.
>
> Providing power and communication services anywhere requires a wire conductor within a conduit (sheath, raceway, plane under carpet squares, raised floors, etc.) connected to a terminal within the room and/or above the ceiling. The degree of flexibility varies among systems - and initial costs vary commensurately. Undercarpet cable can go anywhere. Wiring below access floors can go anywhere there is an "electrified" panel. With cellular flooring and underfloor ducts, flexibility is governed by the spacing of electrical cells, but the flexibility can be enhanced by augmenting these systems with carpeting tile."

Rush (54) observes that the major features of the open office system has led to the popularity of the underfloor system for electrical distribution and communication. The replacement of permanent walls with partitions and dividers and the movement of desks away from exterior walls have had the effect of decreasing the potential of walls for power distribution purposes. The selection of the particular wiring approach taken is dependent on the likelihood and frequency of change in workstation location and/or configuration. For example the number and spacing of service fittings in an electrical grid configuration can dictate the degree of flexibility available (assuming no flat-conductor cable system). Rush makes the point that every underfloor system shares the requirement to penetrate the actual floor surface, but the particular method used can be as simple as a lid, or as complex as a hole drilled through a concrete slab.

Rush discusses several underfloor systems that are being increasingly use today:

3.3.3.1 Electrical cellular deck

A matrix of preset service fittings is spaced approximately just below the surface floor in a trench. The required service is obtained by punching a hole through a thin panel, and bringing the appropriate cables through the opening. The system provides great flexibility with a minimal change in required floor depth to accommodate the system. Physically, the wiring must penetrate the floor, and in the case of carpet tiles, the carpet might have to be cut out or peeled back. Service fittings are sometimes flush with the floor, but frequently they project through the floor, causing an unsightly appearance and a potential tripping hazard.

3.3.3.2 Raised Floor

This approach was originally taken to accommodate the special requirements of major computer facilities. Since many types of spaces require the use of conventional floors (bathrooms and washrooms), ramps, steps, or sunken floors have to be accommodated in some locations.

3.3.3.3 Concrete Underfloor Systems

An underfloor raceway can run within the structural depth of the floor or be placed on the completed floor slab. "Once the main trench duct has been placed, the branch ducts can be spaced at virtually any interval. Preset fittings poke up from the duct desired. Perhaps it is because of this inherent freedom, and the history of the success of this approach that the underfloor duct systems have been so little altered over the year."

3.3.3.4 A Plug in a Poke

This system does not require any underfloor raceway. The conduit runs from its connection to the service fittings on the underside of the slab to the currently spaced junction box. A sleeve may be preset during construction or after. When a hole is drilled, a sleeve is forced into place and the service fittings is then installed from above. The first costs of this system is attractive, but change is difficult.

3.3.3.5 Flat Conductor Cable

This approach is receiving increasing attention today. Cables can be mounted directly on the floor (with a hidden protective metal shield) under existing carpet tiles. Locational changes and/or new systems are installed by simply raising the carpet tiles in the desired path, and redirecting existing flat cable runs or by tapping into a run. Connections between flat and round cables are made at transition boxes, usually located in walls or columns. A major consideration in the use of flat cable systems is to ensure that they are shielded against puncture or other contact. Pearce (55) lists the following benefits of these systems.

- ° Short installation time.
- ° Simplified specification of branch circuit wiring (e.g., no drilling).
- ° Maintained structural integrity of the floor system.
- ° Elimination of slab height increase needed with floor ducts.

Lilly (56) offers the following observations about flat cable, based upon the experiences of his organization:

- ° Cable ridges might be evident shortly after installation of work stations. This problem might be a temporary one.

° The steel cable cover for the flat cable should not be reused; it often does not retain its shape when changes are made, causing the carpet tiles to become uneven.

Ceiling based systems offer an alternative to the underfloor systems described above. In these designs, the power is brought down to individual work stations by means of power poles or by using flexible tubing with connect to office panels (57). This approach is said to be more acceptable to owner occupied buildings than for speculative structures because of added first-cost requirements.

The review of published findings revealed limited and fragmentary office automation design information. While some acoustic, lighting and power distribution design issues were touched upon, they represent the viewpoint of an individual rather than the consensus of a larger community - design, research or engineering. Other data appearing in this chapter and elsewhere in this paper deal with the design of the traditional office, not the automated one. This information represents the state-of-the-art consensus of the scientific community, which might or might not be changed by the additional concern for office automation activities.

While the survey findings are largely based upon traditional office environments, the issues that they raise concerning the demand for improved environmental quality and individual control of the workspace, are echoed and reinforced by the experience with office automation tasks, as will be evidenced in later chapters. Finally, a number of conceptual schemes to develop design information have been noted and described. The need still exists to develop appropriate planning tools to integrate the traditional building systems with the informational, communications, monitoring, and other operational office systems, as part of a comprehensive design program activity.

4. ERGONOMICS

4.1 OVERVIEW

The development of design criteria for automated offices is ultimately dependent on an understanding of the needs and desires of the people who use buildings. Criteria must be responsive to the requirements of an individual as a contributing member of an organization and as a human being with personal and social needs. The discipline of 'ergonomics' deals with the interaction of the person with his surrounds - environmental, workspace, informational, social, and technological.

New technologies influence the ways that people perform work. Zuboff (58) examines the history of mechanization in industry and concludes that the resistance to change evident when jobs are automated in the factory is being repeated in the offices which have been automated. Her findings are based upon interviews with more than 200 employees, managers, and professionals from several large organizations. Her study was designed to investigate the acceptance of computer-mediated work.

Zuboff notes that information technology alters the relationship between the person and the task being performed as well as the way that managers interact with their staffs and other members of their organization. With respect to the task, the computer now serves as an intermediary between the person and the tangible tools and products that are usually worked with. She draws an analogy between the office worker and the craftsman who knows the feel of the materials as they are being shaped and transformed into end-products. In the case of the craftsman, the feedback information is tangible, familiar, and contains a variety of sensory attributes (e.g., tactile, visual), while the feedback for the computer-mediated worker is in the form of abstract, symbolic information. Furthermore, computer-mediated work demands conceptual skills which may or may not be present in office workers, and therefore considerable training might be required to acquire these skills.

Information technology can be used as a means to depersonalize many office tasks by restricting the range of options available to workers in the performance of their jobs. For example, procedures can be automated, requiring employees to perform routine functions. Furthermore the technology exists for supervisors and managers to monitor in detail how jobs are performed, and the nature of the information used to make decisions. The author suggests that systems planners must guard against the depersonalization of the workplace and the disruption of social contacts and should instead facilitate the opportunities for employees to make creative contributions to the organization. An important means of accomplishing this result is to provide the freedom to employees for exercising judgements by not overly structuring the jobs that they do.

Hendricks et al. (59) developed a comprehensive guide for the development of ergonomic data for management information systems. Figure 8 presents an overview of the approach taken to analyze the workplace. The methodology used to develop information is based on the administration of detailed questionnaires and checklists.*

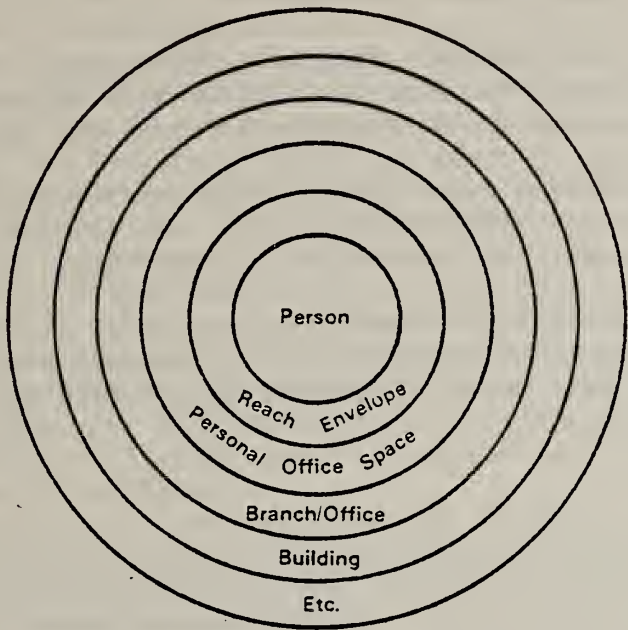


Figure 8. Expanded levels of the environment affecting personnel performance (Hendricks)

Stout (60) emphasizes that productivity gains do not depend solely on technological factors, but instead on a spectrum of activities including people, management and technology and that the ergonomics area provides the greatest potential for improvement, because of its neglect. The following table lists some of the factors which can significantly influence productivity:

After describing several theories formulated to explain productivity, Stout discusses seven major job-related and personal changes brought about by office automation.

(1) Make-up of the work group. People are often regrouped to make most efficient use of the equipment. Long term work relationships are disrupted.

(2) Social relationships. The number and type of social contacts change because of acquiring information electronically rather than as a result of personal interactions.

(3) Duties, skills and job potential are altered. Old career paths may no longer be available, and new ones are opened up. Managers must be sensitive about creating dead-end jobs.

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* Table 39 appendix.

(4) Responsibilities are modified. The introduction of technology can be a means of downplaying the contributions of the worker by attributing increased productivity to the machine.

(5) The degree of job autonomy changes. Office workers must respond to conform with the characteristics of "the machine" and have limited freedom to exercise their judgement in many work areas.

(6) The work environment is changed. Characteristics of the space - e.g., noise, lighting conditions, and of the work setting - e.g., lack of privacy, can result in lowering of productivity.

(7) The person's self-image, status and motivation may change. All of the above factors must be attended to if office automation is to achieve its potential as a means of increasing job satisfaction, and in turn, job productivity.

Table 10. Factors Influencing Productivity (Stout)

People Factors	Management Factors
• Satisfying psychosocial needs • Motivation, interest, goals and values • Personality • Group dynamics/psychology • Attitude toward the work and the organization • Outside influences/goals/problems • Pay and other incentives • Skills, knowledge, training and experience • Human-machine interface • Health, stress and endurance • Interest and challenge of work itself	• Procedures and workflow • Controls, feedback and adjustments • Management style, leadership and employee relations • Organizational structure (and the informal structure) • Incentives, punishments and expectations for performance Technology Factors • Tools, machines and technological knowledge • Applicability of a specific technology to a specific task • Specific cost savings and other benefits resulting from using technology • Benefits that come only from the "confluence of technologies"

4.2 THE WORKSTATION

The workstation is the basic unit of office planning and layout, whether it be a secretarial or data processing station, or the office of the chief executive of an organization. All spatial arrangements and circulation patterns are an outgrowth of the interrelationships of workstations in the view of Kaplan (61). From an ergonomic standpoint, the workstation 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 taken into account in its design. The specific placement of components, equipment and furniture requires a consideration of the way that the body moves, and the requirements for physical comfort. Manual controls must be designed to accommodate the movements required to perform a given task, and displays should be designed and environmentally situated for ease of use. The size of individual components, the clearances between them, and the allowance for movement, are all integral to the proper fit of the person to the workplace. Finally, the workstation does not exist in isolation, but is part of a total environment.

Bair (62) sees the need for OA systems to respond to the way that people typically think and work, with one focal point - the work station. The system should also be highly adaptable, flexible, and permit the implementation of new developments in technology as they become available, with minimal disruption to on-going activities. Bair suggests the following guidelines for office systems. The first two guidelines deal with the interface languages used by the computer operator.

4.2.1 Command and Communication

The language requires a consistent syntax, one which contains the same structural elements as a natural language. The recommended syntax is verb, noun, qualifier, address, and a confirmation of the command sequences, such as key labeled 'OK'. Table 11 illustrates several possible commands.

- Subset of Natural Language (User's Words)
- New Services Require More Extension of Language by Builder or Users
- One Consistent Systax:

Table 11. One Language for Command and Communication (Bair)

Verb	Noun	Qualifier	Addresses	Confirm
Delete	Word		(point)	OK
Move	Branch		(from)(point) (to)(point)	OK
Print	File	Copies		OK
Show	Personnel (record for)		(person)	OK
Compute	Cash (flor for)		(dates)	OK

4.2.2 Current and Future Systems

Another consistent language is required to access OA subsystems. Table 12 illustrates this approach.

Table 12. One Language for Current and Future Services (Bair)

Subsystem	Commands
MIS	Retrieve records (for) product (line) (product) OK
Communicating	Send message (at) (point (to) (distribution list) OK
Personal	Remind me (that) (event) (on) (date) OK
Forecasting	Project earnings (using) (scenario) (from) (time) OK

4.2.3 One Virtual Display Map

All services and systems should be accessible to the user by means of one display that is subdivided into windows which are assigned functions consistent for all applications. For example, one window would present all commands available, another would provide immediate feedback to the user on whatever activity is being performed at a given time.

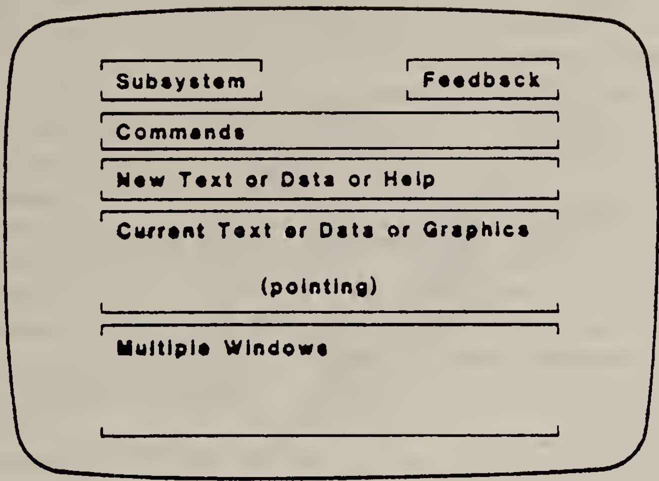

Figure 9. Same functional windows for all applications (Bair)

4.2.4 One Frontend to Current and Future System

This system maintains the command language and the display. The 'frontend' interprets what the user specfies and interacts with the 'backend' of the computer, which performs the detailed operations desired. The frontend can be customized to suit the individual user, requiring only the specification of the job to be performed. For example, the user may request information of a certain type but the backend would perform the operations to determine whether a local or remote network should be accessed for the information.

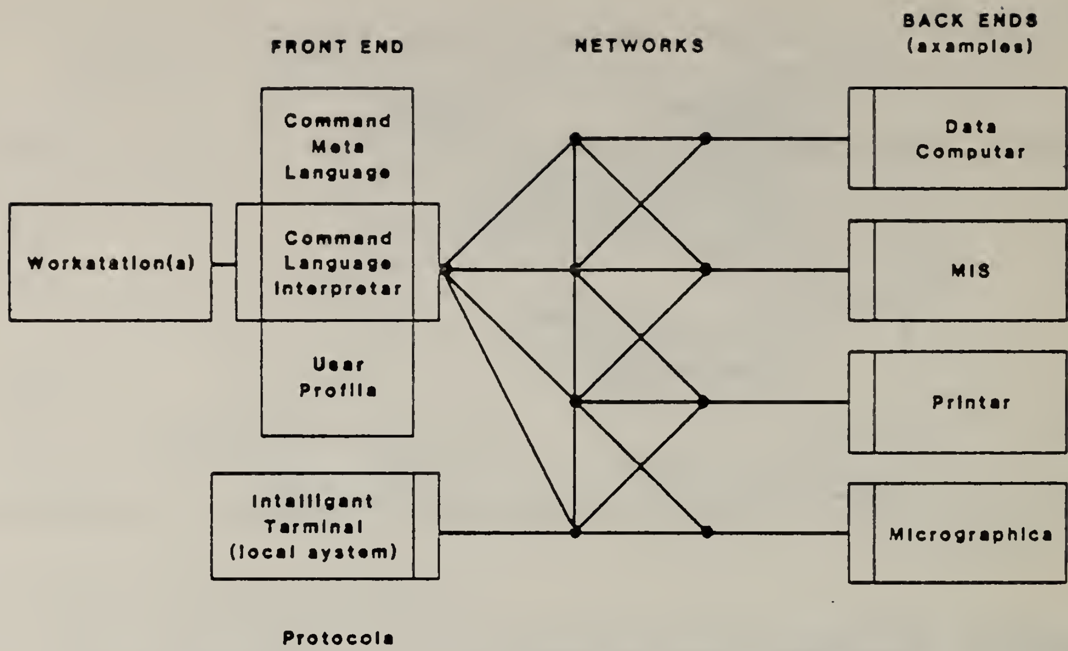

Figure 10. One frontend system (Bair)

4.2.5 One Interface: Work Station and Environment

Central to the system described by Bair is the workstation itself, which operates in a complex informational environment.

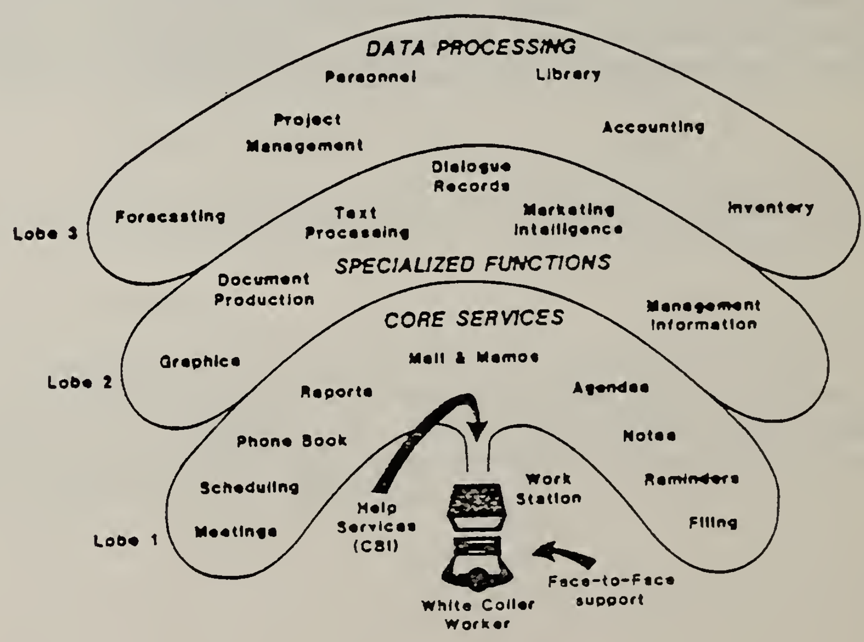

Figure 11. One interface: workstation and environment

Schoichet (63) shares Bair's concept, indicating that the workstation has the versatility to address all of the worker's computer needs with a single integrated system. It is dedicated to the single individual; instant availability and personal control characterize the work station. In terms of hardware, a personal work station is a system which gives the user his own screen, processor, memory and mass storage, and provisions for resource sharing. The workstation is a logical culmination of many recent developments, such as intelligent terminals and minicomputer networks, that were designed to overcome the disadvantages of timesharing and distributed data processing (DDP) systems (poor user responsiveness). The ability to dedicate significant computer power to the individual has several economic implications. The simplicity and standardization inherent in them lead to lower costs and higher reliability. Dedicated nodes, integrated by means of local area networks (LAN) result in systems with low incremental growth costs, and virtually unlimited size.

4.2.5 Analysis of the VDT Workstation

4.2.5.1 Activities Performed

Grandjean (64) distinguishes between two different kinds of activities performed at VDT workstations. One is an interactive system where the operator inputs data by a keyboard and receives feedback information by means of a display. In this type of work, the operator spends half of the time reading source documents and the remainder of the time is devoted to reading the VDT display. The other activity is where the operator spends virtually all of the time looking at source documents, with the balance of the time expended viewing the screen or the keyboard. The operating speed at this type of task is said to be considerably higher than in interactive work.

4.2.5.2 Entering Information

The means of entering information is important for the effectiveness and acceptance of new technology. Keyboard entry is the dominant mode today, but new technology is facilitating the use of equipment by inexperienced and occasional users of OA. Dedicated function keys provide the opportunity to perform complex operations by activating complete programs. Controls such as the 'mouse' or a 'joystick' which translate movements over a convenient surface into corresponding movements of a cursor. Pointing devices such as light pens or the touching of the screen with a finger to select an time from a 'menu' are other modes of data entry requiring limited expertise and experience by the user.

4.2.5.3 The VDT Viewing Task

Wood-Robinson (65) observes that some of the visual tasks involved in using a VDT differ from those encountered in a traditional office. The self-luminous nature of the screen characters and the three task areas of source material, keyboard and screen present a challenge to the lighting designer. The light reflecting on the VDT screen cannot help the viewer in any way, and will usually impair the visibility of the message to be seen.

4.2.5.4 The Hardware Interface

Users will probably be spending much of their workday seated at a workstation - it must be designed to permit ready access to all tools and materials without undue stress or discomfort. Keyboard and display design as well as chairs and other furniture are required to allow a comfortable working posture.

4.2.5.5 The Software Interface

Command language used by the operator to use the system must be chosen with care, as must the dialogue for making use of facilities such as text processing and message routing.

Galitz (66) emphasizes the need for systems approach to the design of work stations, based on the effectiveness of the worker, who is at the core of the system. Figure 12 illustrates his concept.

Shackel (67) provides a broad overview of the ergonomic considerations in an automated office, table 13.

4.2.2 Problems with VDT Workstations

The video display terminal (VDT) is the basic device used in all office automation systems, and it is therefore not surprising that it has received considerable attention by ergonomic researchers. Their major concern is to ensure that the design of the terminal and inputing devices are responsive to the various needs of operators. A number of concerns have been identified with respect to the operating characteristics of the VDT's themselves, as well as the overall operating environment in which they are used.

Brown, et al. (49) report on the result of a Symposium conducted by the National Research Council of the National Academy of Sciences. They indicate that the most common complaint expressed by VDT operators is visual fatigue. The term is used to describe symptoms of ocular irritation, burning, blurring of images and double vision; for the most part these changes are temporary in nature according to current research findings. Several factors are said to contribute to visual fatigue; the quality of the CRT system, general lighting conditions, workspace design and job related factors.

With respect to the design of displays, the quality of displays often used in the workplace are no better than those used in home television sets, which were never intended for close viewing and prolonged work activity. Many problems with lighting in VDT workplaces are caused by their introduction into environments designed for desktop work. VDT displays create new geometrical relationships between work surfaces, resulting in visual problems.

Another study by the National Academy of Science (68) revealed that there is no evidence to support the belief that VDT workers are being exposed to health hazards, but inappropriate work design is likely the cause of many complaints. For example, poorly designed VDT's are placed on traditional desks, with work being performed in cramped space, and with limited room for documents holders or manuscripts. This results in work being performed in uncomfortable working

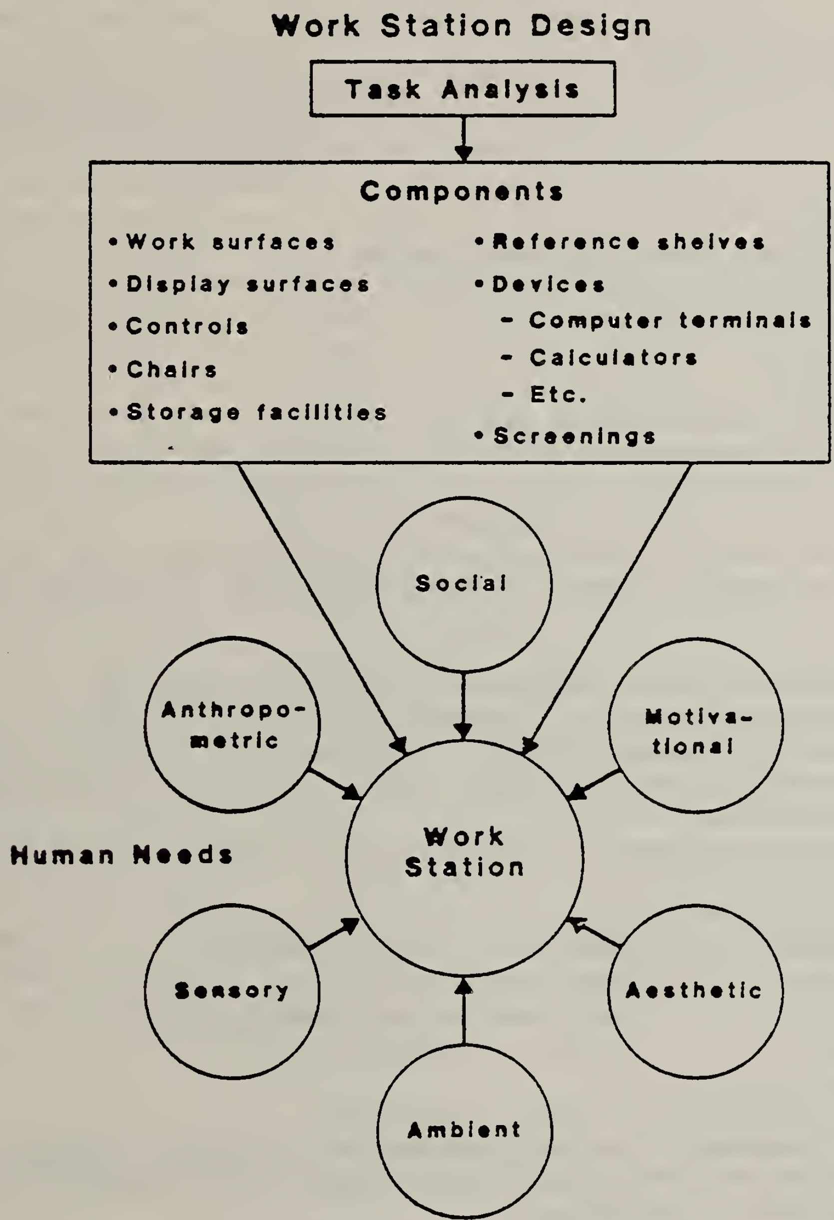

Figure 12. Conceptual analysis of work station design, (Galitz)

Table 13. Major Factors in Man-Computer Interaction (MCI) (Shackel)

Human Performance

- Basic characteristics and limitations, e.g., size, seed, skills, errors, flexibility etc.
- Special aspects e.g., selection, training, user support — e.g., modeling the user, decision making, problem solving

Computer System Performance

- Basic characteristics and limitations, e.g., capacity, speed, reliability
- Special aspects for MCI — e.g., language facilities, system response time, security

Hardware Interface

- Displays, controls, terminals and consoles
- Applied ergonomics for good workstation design
- Human need and new devices

Software Interface

- The non-hardware communication media
- Languages and linguistic systems (MCI apsects)
- Information organization
  - e.g., logical structural of content and procedures
  - e.g., message structure and verbosity, display format and layout including e.g., microfilm output, questionnaires and other input forms)

Environment

- Physical workstation space and layout, lighting, noise, etc.
- Psychological, influence (e.g., via motivation, strain, etc.) of the working group, of the job structure (e.g., shift working), of the system structure (e.g., open closed, rigid flexible, etc.), the solid climate and of the organization design
- Applied ergonomics and social science for good environment design

Specific application -- e.g.:

Specialist users	Computer assisted learning
Business users	Computer aided design
Naïve users	Man computer telecommunications
Public systems	Computer conferencing

Special problems -- e.g.:

- Evaluation -- especially criteria and methods
  - -- especially social implications versus cash costs
  - -- importance of real world studies (not laboratory only)
- Privacy of personal information
- Ergonomics of programming and the job of the programmer
- Documentation and related job aids
- Influence of MCI upon job design and organization design
- Influence of MCI upon society

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postures. Operators working in such situations are likely to experience visual discomfort, muscular discomfort and fatigue. Working at a VDT places a number of interacting demands on the visual and musculoskeletal systems that differ from the traditional office. If the VDT is at a comfortable viewing distance, the fixed keyboard is sometimes at a distance that requires the operator to hold his or her hands, wrists and arms in uncomfortable positions.

Static muscle load and postural stress, discomfort and fatigue created by the fixed postures can be relieved by moving the body. Operators should be able to readily change positions at their workstations.

Many VDT based jobs are badly designed; they are characterized by the need to perform repetitive tasks at a fast pace, with little or no opportunity to vary the pace or the work, or even adjust to uncomfortable equipment. Such jobs are often seen as being highly undesirable in that they stifle initiative creativity, and sense of achievement. Total job design consists of determining what the worker is expected to do, the methods and procedures to be followed, the skills and abilities required to perform the job, and the interactions with other people working at the same location. One approach to examining job stress is to determine the fit between the person and the environment from two standpoints: the fit between the needs of the person (preferences, values, desires) and the extent to which these are met by the job situation and the fit between the abilities of the person and the requirements of the job. An important influence on the desirability of a given job is the degree of autonomy that individual has:

> "VDT jobs, like other jobs, vary greatly on such factors as the amount of control given an employee and the employee's opportunity to participate in decisions that affect the way in which his or here work is carried out. VDT jobs vary in the extent to which an employee can control the introduction into the workplace of VDT equipment, the amount of incoming work and associated deadlines, the variety of the work content, the amount and scheduling of time spent at the VDT, and the extent of interactions with other people. Although research on VDT use does not permit firm conclusions as to how variations in control influence employee well-being, research on other types of work suggests that lack of control has measurable, undesirable effects on employee well-being. Because individuals vary in their need for control, the person-environment fit approach would predict that lack of (or too much) control can act as a psychosocial stressor for workers in jobs in which there is a misfit between the work and the job on this dimension." (68)

Yates (69) notes that the prospect of change is often a cause for alarm by the workforce. Among the changes which are potentially important are:

° Working hours (e.g., a decrease made possible by higher productivity or an increase to ensure full utilization of an expensive system).

- Working environment (e.g., an improvement if noisy or hot equipment can be remote-controlled or a degradation if poorly designed visual display terminals are installed.)

- Type of tasks (e.g., automation of tedious tasks or introduction of apparently meaningless procedures dictated by the machine.)

- Variety of tasks (loss of visits to other offices, loss of some tasks, introduction (of others.))

- Pace of working (e.g., automation could eliminate intermediate steps to final decisions, individual could lose his control over pace of work.)

- Skill requirements (some jobs could become deskilled, others could require additional skills.)

- Supervision (machine could provide data on performance - could be used as means of tightening supervision or could provide valuable feedback to the operator.)

4.2.3 Planning the Workstation

Kroemer and Price (70) note that the present day workstation and job design is a holdover from the orientation of equipment and furniture manufacturers that their designs should accommodate the 'average' person. The concept of the average person has now been discarded by researchers and designers with the recognition that it is necessary to accommodate individuals who come in a wide variety of shapes and sizes, as well as having different preferences for equipment and furnishings. Just as the design emphasis today for office automation is on the need for flexibility, there is a parallel interest in furnishings and workspace design, for adjustability by the individual to suit personal needs and tastes. A major consideration for determining the range of adjustments needed for office furnishings and equipment are bodily dimensions, as outlined in table 14.

An equipment office automation study performed for Barclay's bank in England was reported by Taylor (71), and has led to the establishment of a number of guidelines for introducing such systems. Among them are the following:

They specified that the keyboards for equipment not be attached to the display unit, but be connected by means of a flexible cable. This design enables the operator to adjust the keyboard to suit his or her individual working style. With respect to lighting, one requirement is that light sources be shielded to prevent direct reflections on the CRT screens. Clean power, independent from electrical surges from other building equipment (e.g., elevators) is an important consideration in the installation of office systems. Based on the experience of implementing a number of office systems at the Barclay banks, the following recommendations were made:

Table 14. Selected Body Dimensions Determining Proper Design of Office Work Place Components (Kroemer and Price)

Location/Adjustability/ Dimensions of Work Place Components	Relevant Human Data
CRT/source document	Eye height above seat; preferred direction of sight; trunk/neck posture
Keyboard/wrist rests	Finger and arm dimensions; shoulder height; trunk posture; muscle tension in fingers/ arms/shoulders/trunk; finger mobility.
Writing surfaces	Seeing distance; arm dimensions; shoulder height; muscle tension.
Backrest of chair	Sitting height; shoulder height; back curvature; muscle tension; mobility of trunk/shoulder blades/arms; buttock-knee length.
Seat pan of chair	Buttock-knee length; hip breadth; body weight; popliteal height.
Leg room	Buttock-knee length; thigh height; hip breadth; lower leg length; patella height; leg length; foot length.

- The correct office environment should be described, and in place, before installing any system. More efforts expended during the design stage result in greater savings during implementation, and a higher degree of acceptance by employees involved in the design process.
- Users should be involved in pilot system studies, to obtain their ideas and familiarize them with the changes being planned-technological and organizational.
- In order to minimize problems associated with electrostatic discharge (e.g., annoyance, deleting data in memory), a number of suggestions were offered.
  - Use an anti-static spray, applied to the floor or carpets.
  - Use a humidifier to increase the humidity level in the workplace.
  - Use anti-static carpeting, which limits charges to the 5,000-6,000 volt range.

- Place equipment directly on mats impregnated with carbon.
- Alter traffic patterns around computer teminals.

Taylor outlines a team-oriented approach to office automation with the goal of enriching the various tasks performed by employees. He suggests that several steps be taken when planning and implementing these changes.

- Scanning the work group. Determining what product is being produced by the group, the boundaries of the group (where in the work process that they interact with other groups), the inputs that they receive, and their reporting relationships.
- Problem solving. For each problem identified, what solutions are typically required to solve the problem, and who is responsible for solving the problem. One objective is to determine where supervisor intervention is needed.
- Social system analysis. Examination of the role of each worker within the group, and the relationships of groups to one another in completing tasks. A primary goal is to determine when problems originating in one group must be solved by another group.
- Socio-technical design. Once technical and social elements of the process are analyzed, they can be recombined in new ways - to permit problems to be solved within the group where they originate. Employees can thereby have greater control over their work place and the jobs that they perform. This approach is said to result in improved quality of products and services, and decreased costs.

Workstation manufacturers were asked about their design criteria (72). A summary of the major issues noted by them appears below:

1. Detailed analysis of requirements
    - Communications
    - Storage
    - Tasks to be performed
    - Need for flexibility
2. Environment/design issues
    - Acoustic privacy
    - Glare-free lighting
    - Freedom from auditory and visual distractions
    - Physical separation of unrelated activities
    - Ease of power changes and additions
    - Non-disruptive traffic patterns

3. Ergonomic factors

- Ready access to work materials
- Adequate storage - horizontal and vertical
- Integration of task functions
- Layout of workspace consistent with tasks performed
- Adjustable VDT screens and detachable keyboard
- Adequate work surface
- Easily reached controls and easily read displays

Kaplan (61) notes that the desire for environmental control is not limited to workstation components such as chairs, keyboards, work surfaces, and visual displays, but that it often extends to being able to turn lights on or off and selecting colors for our surrounds. He identifies the need for privacy as the central issue from which other aspects of spatial control emanate. Among these issues are:

- Territoriality - defining of areas and boundaries that are under our control and for our exclusive use.
- Personal Space - the immediate space around our bodies.
- Interpersonal Space - the distance we permit and regulate between ourselves, and others, dependent on the particular situation.
- Crowding - The individual reaction to a number of people within a given area.

Yates (69) indicates that the intrinsic nature of the work itself is an important determinant of job satisfaction. This usually relates to the variety of the tasks performed and the degree of skill needed and the autonomy possible. Among the important factors are: reasonably demanding work with some variety; opportunity to learn; some decision making; social support and recognition; significance and meaning; and future prospects.

4.3 JOB AND TASK ANALYSIS

VDT's are used to perform a broad range of functions which vary with respect to the visual tasks involved, the time spent viewing the VDT, the familiarity of the information processed, and the work schedule. These factors are likely to influence the likelihood of visual and other job-related complaints. The factors examined in job analyses should include the determination of whether a requirement exists for repetitive eye movements from hard copy to the VDT screen and whether there are rigid requirements with respect to the activities and time spent at the VDT, as opposed to having sufficient flexibility to temporarily modify the work pattern if discomfort is experienced (68).

4.4 ARCHITECTURAL PROGRAMMING ISSUES

Many office layouts and plans for office automation do not succeed because of inadequate architectural programming and planning according to Kaplan (61).

For programming to be effective in providing an appropriate work setting it must cover organizational, motivational, communicative, ergonomic, functional and technical factors. Four major areas must be covered in programming. (Figure 13 illustrates his general approach.)

<u>Essential Programming Information</u> (Kaplan)

- <u>Objectives and Philosophy</u>. A clear statement of goals is the first step. These are based on the history and background of the organization and its attitudes and expectations towards its client and staff.

- <u>Functional Relationships</u>. 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.

- <u>Facility Spatial Requirements</u>. Spatial needs for individual and organizational units are based upon a complex of interfacing factors such as ergonomics, communication requirements, status, and needs for privacy.

- <u>Development of the Program and Program Criteria</u>. The program should be written in performance language, describing the functional requirements of a system for example, not the hardware specifications.

- <u>Post Occupancy Evaluation</u>. To prepare for future evaluations, a log of projects should be kept and preserved, including all plans, the program, decisions and changes made. Evaluation should be made on the basis of general staff satisfaction, staff use of space and facilities, environmental and communications systems, task performance, and the value and use of staff amenities.

4.5 USER INVOLVEMENT IN PLANNED CHANGE

Damodaran (73) notes that user involvement is needed to ensure that new technology is compatible with other aspects of the work situation, skills, expectations and work roles. A good fit between the user and the office systems requires detailed analysis of the job. The real expert on many tasks is frequently the job occupant. Potential benefits of involvement are: greater degree of commitment and cooperation as a result of participating in the change process, and improvement in the quality of the design decisions because of the expertise of the users supplementing those of the other design team members.

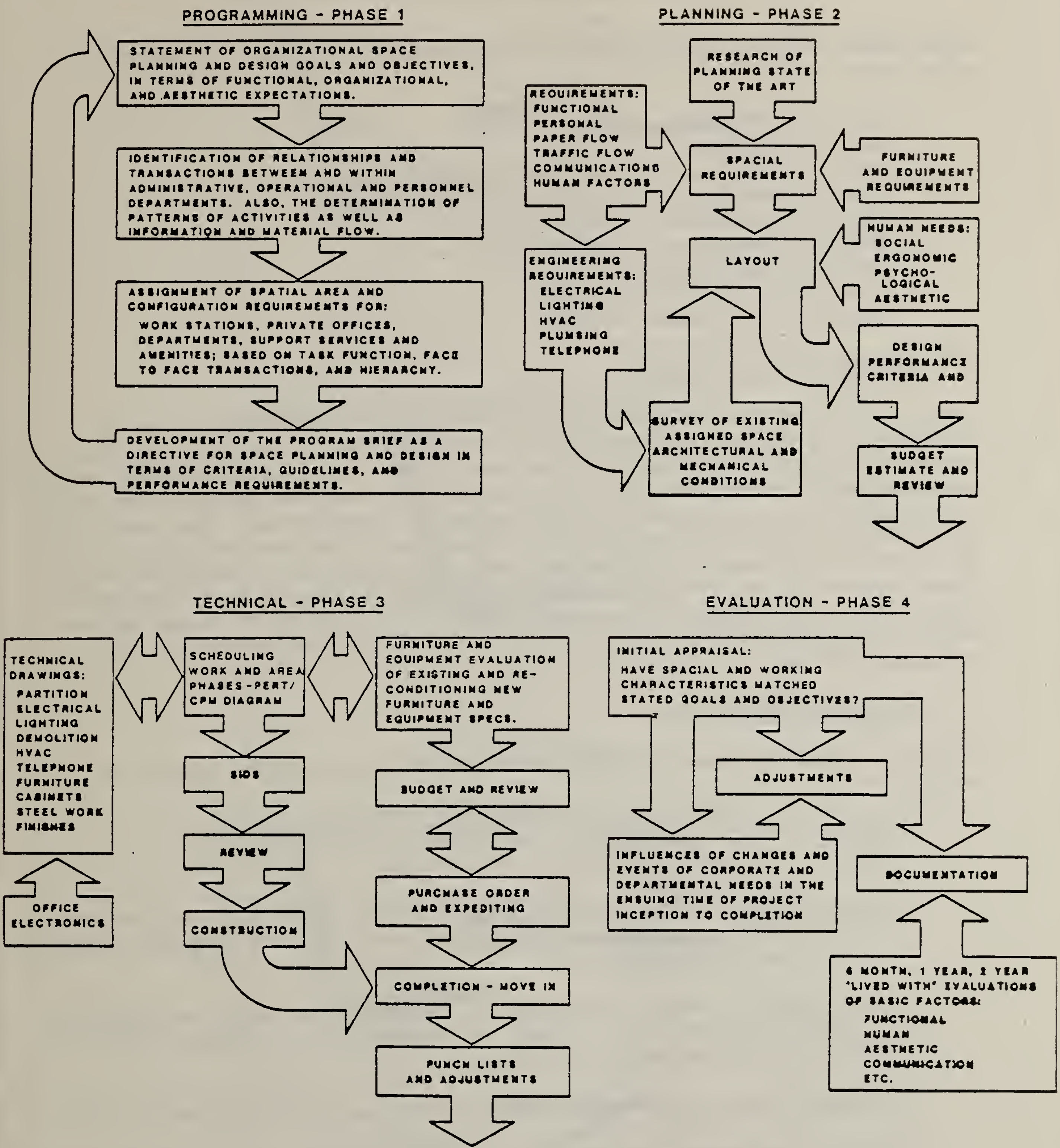


Figure 13. Office design process (Kaplan)

Areas where users can make specific contributions about the performance of given tasks are:

- ° non-routine events
- ° queries generated
- ° "bottle-necks" and interruptions in work flow
- ° human interactions in the work process
- ° procedures/techniques/special skills
- ° documents/reference books/equipment used
- ° task interdependencies
- ° storage facilities
- ° layout of work place

4.6 INSTRUCTIONS AND TRAINING

Information about the use and maintenance of systems is critical. It is important to know the knowledge, skills and abilities of the user population and the preconceptions that they bring to their task. Two classes of users must be accommodated - experienced and inexperienced. As the user becomes more expert with practice, this increase in skill should be accommodated. The rate of progress will be governed by the skill of the operator and the frequency of use. The instructions need to be flexible, presenting detailed information only to whose require it, but responding to the needs of the expert with abbreviated instructions. Training programs are also an effective way of preparing the staff to cope with the new technologies which have to be mastered in the automated office.

4.7 DESIGN RECOMMENDATIONS

Kroemer & Price (70) describe some of the functional requirements for VDT operators:

- ° Display. Must be located at the proper seeing distance and at the preferred inclinations of the line-of-sight.

- ° Source Document. The distance depends on the ability of the individual to focus with or without spectacles (as required), and the height depends on the line-of-sight desired.

- ° Work Surfaces. Should be located at the preferred height and distance for ease of manipulation, support of forearm, palm and wrist, and convenience for seeing visual task.

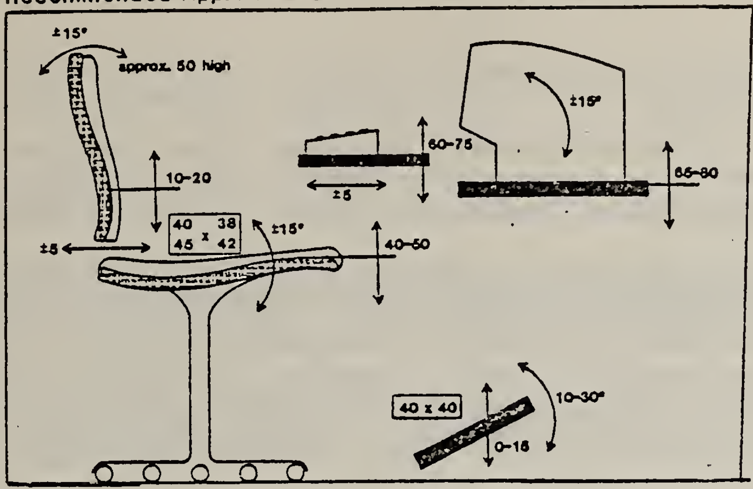
- ° Leg Room. Lower extremities should be accommodated with room to move.

- ° Seating. Adjustability is essential to accommodate different body sizes and posture. Firm back and neck support are required.

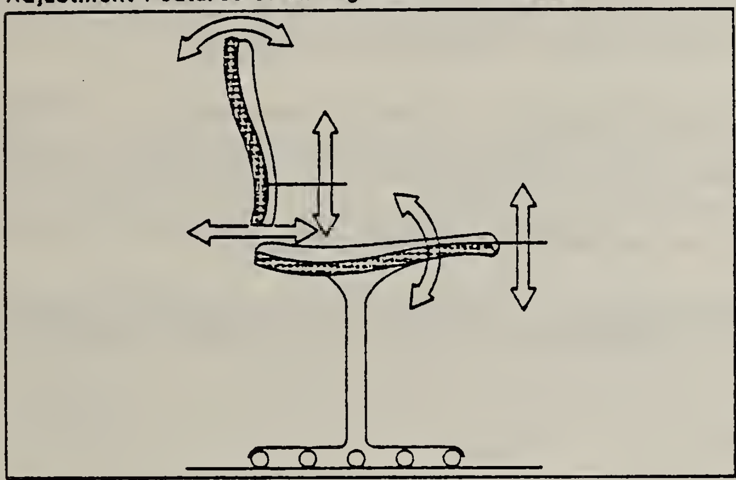
- ° Keyboard. Should be detachable from VDT for individual convenience and preference.

Figure 14 indicates the authors' suggestions concerning workstation design.

Recommended Approximate Dimensions (in centimeters)



Adjustment Features of an Ergonomic Work Seat



Adjustment Features of an Ergonomic VDU Work Station

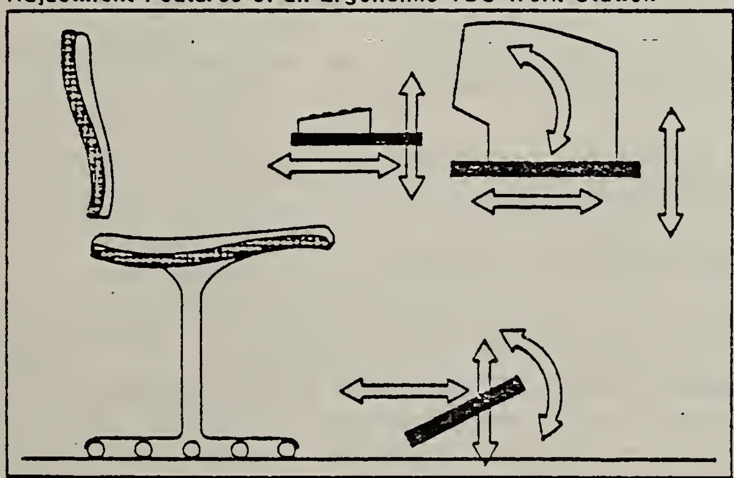


Figure 14. Workstation and seat design (Kroemer and Price)

4.7.1 VDT Filters

Filters can be placed over screens to reduce glare, but have to be used carefully because they can result in loss of image quality. The National Academy of Science study cited earlier (68) note the following approaches:

"° <u>Circular Polarizer with Antireflective Coating</u>. Use to reduce both specular and diffuse reflections. The outside surface is coated with several layers of optically transparent materials to form an anti-reflective coating to reduce specular reflections from the surface of the filter. The remainder of the filter package is a polarizer to eliminate reflections from the underlying VDT screen.

° <u>Neutral Density Filters</u>. The simplest filter, consisting of a neutrally tinted plastic allowing a small percentage (usually 15-25) of the light falling on it. It is more effective in reducing diffuse reflections by light from ambient sources.

° <u>Notch or Color Filters</u>. Allows transmission of a high percentage of light from certain wavelengths (usually green), and absorption at other wavelengths. It is designed to be 'tuned' to the color of the VDT screen, permitting the desired light from the VDT to come through, while absorbing the undesirable ambient light.

° <u>Directional Filters</u>. Use geometric or optical means to prevent ambient light from reaching the screen to prevent reflections from reaching the user."

4.7.2 Glare Control

Direct and reflected glare should be limited by means of one or more of the following method according to Murray (74):

° Drapes, shades, and/or blinds over windows should be closed, especially during direct sunlight conditions.

° Terminals should be properly positioned with respect to windows and overhead lighting.

° Screen hoods may be installed.

° Anti-glare filters may be installed on the VDT screen.

° Direct lighting fixtures may need to be recessed; and baffles may be used to cover fluorescent fixtures to prevent the luminaries from acting as a glare source, or special covers on light fixtures may be used to direct the light downward rather than allowing the light to diffuse.

° Properly installed indirect lighting systems will limit the luminaries 'potential as glare sources, although some reflected glare may still be present.'

4.7.3 Work-Rest Regimes

Murray (74) indicates that: "based on our concerns about potential chronic effects on the visual system and musculature and prolonged psychological distress, we recommend the following work-rest breaks for VDT operators:"

1. A 15-minute work-rest break should be taken after two hours of continuous VDT work for operators under moderate visual demands and/or moderate work load.

2. A 15-minute work-rest break should be taken after one hour of continuous VDT work for operators under high visual demands, high workload and/or those engaged in repetitive work tasks."

4.7.4 Postural Concerns

Grandjean and Vigliani (64) make the following workstation recommendations:

° Movable keyboards are better than sunken keyboards.

° Special, separate devices to adjust the height of desk or keyboard level source documents terminal screen are recommended.

° Forearm/hand supports are indicated, but studies to develop appropriate designs are necessary.

° Chairs with high backrests and adjustable inclination are recommended.

Ketchell (75) conducted a study of 20 VDT operators, and table 15 summarizes the major complaints noted by them.

4.8 COMPUTER SYSTEMS FOR END USERS

Englebart (76) describes the automated office in terms of a system comprised of "tools" and a "human system". To date, the office tools have been the focus of attention by system and hardware designers as well as organizational managers. He suggests that if the human system components are not given comparable consideration, the tools will be "out of control", making it very difficult to design effective system for end users. Englebart describes the system elements in the metaphor of a craft, which is suggested as an accurate characterization of the requirements of a knowledge worker.

Table 15. Significant Complaints and Findings of VDT Operators (Ketchel)

• Heat	- Equipment generates heat which is often not adequately removed by the air conditioning system.
• Lighting	- Sun glare and artificial lighting require adequate control. Some type of glare shield, CRT etch, or anti-reflective coating is necessary.
• Noise	- Printers are noisy. A noise cover is required if the printer is in the same room with an operator.
• Training	- Technical training by the vendors is typically 2.5 to 3.0 days. This provides basic familiarity, but not proficiency. On-the-job training, continuing vendor support, and good reference materials are important.
• Stress	- Supervisors and staff members who use VDT operator outputs tend to expect instant proficiency from newly trained operators. It actually takes about 6 weeks to reach high performance. Education is required to avoid false expectancies and resultant operator stress.
• Planning	- Operators should have a major role in decisions about which equipment to buy and how it is to be used. Consideration should be given to scheduling, priority setting, inter-group cooperation and equipment compatibility, and specific system features.
• Vendor Support	- Reliable, prompt and effective vendor support is important for installation, maintenance, and training.
• Shared Equipment	- Some problems in priorities and scheduling occur when equipment needs to be shared by several people.

Architects have a potentially significant contribution to make to organizational effectiveness in the design of individual workspaces as well as the general environment shared by the office staff. The studies cited earlier have pointed to the importance of workstation features such as furniture and task lighting in performing VDT work. These same investigations have cited the importance of job-design as an important consideration for performing automated office activities. Job-design is a response to the type of work performed at the workstation, and the demands that it places on the office employee, physical and mental.

The design of the office itself can play a very important role in ameliorating some of the difficulties associated with VDT-based work noted earlier. This aspect of design assumes greater importance when we consider that the earlier

The Categories of System Elements (Englebart)

1. Tools: Craftsmen benefit from balanced collections of well-designed tools.

2. The Human System

   a. Methods: To be effective, tools must be used with well designed work methods.

   b. Skills: It takes practiced skill to exercise a competent blend of tool and method.

   c. Knowledge: True craftsmen depend upon much integrated "shop" knowledge.

   d. Craft Language: Craftsmen need an effective means of communicating with one another to discuss, teach, plan and collaborate.

   e. Training: To create an effective group of craftsmen, training is needed in all of the above elements.

   f. Organization: Role differentiation and organization structure are needed for integrating craftsmen into an organization.

findings pertained to people who have been trained to perform VDT work, primarily support personnel. The problems are likely to be intensified as managers and professionals, typically untrained in the use of keyboard devices, are required to work with VDT-based systems. Working in this mode will be particularly difficult because of the lack of user-friendly computer systems. At the same time, managers and professionals, because of the nature of their work, have indicated the need for an environment free from distraction (4.10) e.g., noise, intrusions on their privacy. These factors taken together, suggest both the need for a supportive workspace and attractively designed public spaces for social contact and relief from intensive computer-based work activities.

The advent of office automation is profoundly changing the office as a place to work, thereby impacting the individual worker in many ways that are only partially understood. The electronic revolution brought with it many of the undesirable effects of automation: noise, machine pacing of many jobs, and reduced discretion and autonomy in determining how a particular job is to be performed. A complicating factor is that in many instances automation has been introduced in open-office settings, where sufficient attention has not been paid for the need for privacy. Furthermore, when VDT's are employed, all too often they have been placed on traditional desks as substitutes for typewriters without regard to the differences between the two devices from the standpoints of the operator, or the environmental systems required to support them.

5. ORGANIZATIONAL FACTORS

Organizational issues cannot be readily separated from those of design, ergonomics, and technology. All of these factors come together critically when we consider the need for organizations to cope with changing external environments and internally generated priorities. Ackoff (77) and Probst (78) make the point that the ability to grow and respond to change is the essential prerequisite for organizational survival. The design challenge is to provide an environment with sufficient flexibility and adaptability to support organizational goals and processes as they evolve.

Becker (7), Ackoff (77), and Lodahl (5) suggest that the advances in office technology, and the trend toward an increased percentage of knowledge workers in the workforce is likely to increase the importance of the environmental characteristics of the spaces where office work is performed. As more and more of the routine office processes are automated, more time will be available for planning and creative thinking, which will require spaces conducive to these activities. Such working areas should be free from distractions such as noise and heat, which accompany many of the devices now being placed in offices as part of the OA activities. Dealing with the conflicting demands of equipment and people will be a major design challenge. Another important factor which will tend to highlight design issues is that managers and professionals will be exposed to the same workstation and environmental features as the clerical and support staff. Their past experiences and job demands are likely to sensitize them to the shortcomings of the typical VDT workstation to be found in offices today, and provide an impetus for improved work surrounds.

With the advent of automation in the 1950's, the design of computer-based information (CIS) in complex production processes typically followed one of two paths: 1) using workers to carry out decisions made by preprogrammed automatic control systems, or 2) enabling workers to monitor complex technology, thereby being able to control unpredictable events. The latter approach exemplifies the trend away from the treatment of a man as a machine (or machine component) and the recognition of the unique abilities of people to deal with unstructured and complex information.

Taylor (79), in discussing complex processes such as chemical manufacturing and oil refining, observes that the task required in such systems are usually beyond the capability of one person. The design of work in these instances has often been based upon the integration of management knowledge and skills with those of the workers. The process employed to merge the talents of both groups is termed a sociotechnical approach, based on a systematic analysis of the technology and the patterns of human interaction in an organization. Among the factors examined in such an analysis is work arrangement, reporting relationships, decision making and social support systems, including environmental issues. The need for employee participation in the analysis, design, and implementation of sociotechnical systems is emphasized - with participation including problem definition, and data collection. In discussing the potential of automation for the office worker, Taylor summarizes:

"Computerization does not require fragmented jobs of the assembly-line approach. The technology itself is largely neutral. Whether jobs are made more challenging and congenial or more fragmented and dreary depends on integrative organization design. The difference lies in whether people are regarded as extensions of the machine or the machine is designed as an extension of people. A participative approach to sociotechnical systems analysis can assure that the work of all members is integrated toward a common purpose."

Driscoll (80) believes that most organizations today are spending money on mechanizing existing functions as a means of increasing efficiency - i.e., accommplishing the same work by using fewer resources. Increased efficiency however does not necessarily translate into greater effectiveness, which refers to meeting organizational goals. For example, in some instances ongoing tasks should be eliminated rather than being performed more efficiently. The approach advocated by Driscoll is an analysis of the tasks needed to accomplish the major objectives of the organization, resulting in an organizational redesign. This analysis should be accomplished by relying on end-users for supplying detailed information about the tasks and functions to be accomplished. They are the most knowledgeable resource available to the organization. Organizational redesign, according to the author, ought to have job redesign as a major goal as well - which would result in greater participation in decision making by all members of a given organization. In summary, Driscoll hypothesizes three stages of office automation, mechanization, automation, and organizational redesign. These stages are summarized in table 16.

The office constitutes an information environment, defined as the set of variables that affect the flow of messages into, within and outside of any organization, in the view of Taylor (79). Any such environment can be described in terms of the following:

° What is the organization and what does it do?

° What kinds of media, messages, and technologies exist within the organization?

° What kinds of people work in the organization?

° What kinds of problems do they have, and how can these problems be translated into informal terms?

° What kinds of barriers and rewards exist in the environment?

An understanding of the dynamics and interactions of these variables is needed to design more effective systems and services within formal organizations.

These issues are quite different from the technological emphasis of most computer system vendors and purchasers. They arise from the adverse experiences of past users of automated equipment. For example, Melly (81) indicates that many company executives are now questioning whether their investments in computer systems have been cost effective. One problem is that their exposure to

Table 16. Three Stages of Office Automation (Driscoll)

STAGE	Mechanization	Automation	Organizational redesign
FOCUS	Tasks	Whole Procedures	Missions
CRITERION	Individual Efficiency	Organizational Efficiency	Organizational Effectiveness
FORM	Hardware	Software	Management
DISCIPLINE	Electrical Engineering	Artificial Intelligence	Applied Behavioral Science
ORIGIN	Vendor	Vendor	User
OBSTACLE	User resistance	Programming	Management
FEASIBLITY	Present.	5 years	Present
APPLICATION	5 years	10 years	15 years

data processing has been carefully and strongly directed by hardware and software vendors, who are constantly promoting their new generation of computer technology. These executives are now asking, "What are our company's real electronic data processing (EDP) needs, and can we justify them?" instead of, "What is the state of the art?". These same questions are now being asked by organizational purchasers of OA systems.

Conrath, et al. (82) conclude that the design of the electronic office has been dominated by the thinking of technical experts with little effort expended on understanding the requirements of users functioning in an organizational setting. They see a need to better understand the activities performed in offices as a necessary part of the planning process. An evaluation of operating systems to determine their effects on individual, social and organizational activities is also needed. The first step in this process is the need to define and measure the relevant office automation variables. Toward this end, the authors have developed several taxonomies of office tasks using the following general procedure.

The authors start by analyzing the content (the message being communicated). Next, they identify the source/destination. Identifying an input source or an output distribution should include information about the physical location (affecting the communications network) and the organizational function (impacting the role played by the individual in the operating environment). The mode of communication (face-to-face, telephone, written) is then examined. The work process (individual responsibilities on the job) is then scrutinized, together with the aids (technical support systems) employed in performing a given activity. The final consideration is the significance of the activity from the standpoint of organizational goals. (Table 42 presents an overview taxonomy of office tasks developed by the authors. (appendix, p. 234)).

Young (83) cites several ways in which the office work force can be increased in effectiveness. He points to the decentralized office as an opportunity for employees to stay at home and yet play a vital role as programmers, word processors, data entry operators and analysts. All of these functions can be performed by means of remote terminals. Flextime, part time employment, and job sharing also represent somewhat untraditional approaches to office work, which are becoming increasingly prevalent in today's job market. Young describes these flexible working procedures as being effective due to "decreased absenteeism and tardiness, improved morale, increased productivity and reduced job stress."

5.1 MANAGEMENT ISSUES

Future automated office systems will have to be responsive to the needs of professionals and managers. It is necessary therefore to better understand what they do, and how they do it. The classical description of a manager indicates that he plans, organizes, coordinates and controls. This viewpoint is disputed by Mintzberg (84) by discussing four "myths":

1. THE MANAGER IS A THOUGHTFUL SYSTEMATIC PLANNER. Studies have demonstrated that management activities are typically brief, varied, discontinuous and mostly ad hoc in nature. In most instances the manager responds to external stimuli.

2. THE EFFECTIVE MANAGER HAS NO REGULAR DUTIES TO PERFORM. The manager handles exceptions, negotiations, ceremonial contacts; he is the "nerve center" of the organization, constantly processing "soft" information gained informally from networks of external contacts.

3. THE SENIOR MANAGER NEEDS SUMMARY INFORMATION, BEST PROVIDED BY A FORMAL SYSTEM. Managers obtain and transmit information verbally in most instances. Their information channels are meetings and informal conversations in person or by means of telephone. Decision making and use of information is highly personalized and depends largely on data in their memories, therefore there is a reluctance to delegate responsibilities to those who cannot share this "data base".

4. MANAGEMENT IS BECOMING A SCIENCE. A science is dependent on standardized procedures while management decision making processes are not understood, being based on intuition and judgement. Mintzberg says that managers today are functioning in virtually the same way as their counterparts more than 100 years ago. He summarizes the several roles played by managers in the following table:

Table 17. Managerial Roles - (Mintzberg)

Formal Authority and Status	Interpersonal	Informational	Decision Making
	° Figurehead	° Monitor	° Entrepreneur
	° Leader	° Disseminator	° Disturbance Handler
	° Liaison	° Spokesman	° Resource Allocator
			° Negotiator

Poppel (85) describes the result of a study by Booz, Allen & Hamilton of 15 large representative organizations. They wanted to determine: (1) how managers and other office workers spend their time, and (2) the effect of office automation on productivity. Five major findings resulted from the investigation:

1. Many respondents spend less time than half of their working time on activities directly related to their jobs. Traveling and performing routine administrative tasks are especially time consuming.

2. Almost 25 percent of the time is spent on waiting for people or information, performing clerical chores such as making copies of documents and travel reservations.

3. Meetings, in person and by telephone are the most common form of professional activity (almost 50 percent of the total time).

4. Professionals spend an average of 21 percent of their work time in preparing and/or reading documents. Only 8 percent of their time is spend on analytic work (problem solving, conceptualizing).

5. Most knowledge workers would prefer to allocate their time differently, e.g., spending more time on analytic and planning work, and less time at meetings.

In examining the tasks performed by the respondents, and obtaining insights into how office automation can help the effectiveness of managers, the researchers used the concept of critical success factors (CSF) - those activities most important to performing the major job functions.

The following CSF's were those that were frequently identified by the respondents:

"° Direct, timely access to accurate product, customer, and internal performance information, primarily by making it accessible through terminals or other types of automated work stations.

° Effective intradepartmental communications, mainly through electronic mail systems.

° More effective interaction with customers (both external and interdepartmental), through higher quality documents and faster message systems.

° Adequate, uninterrupted time for work activities most directly related to functional objectives, by taking the time saved from less productive activities."

Alloway and Quillard (86) were also interested in clarifying the role of a manager in an organization. They did this in the context of studying information requirements by conducting a survey of 19 industrial firms, and more than 1000 managers. The study was performed to recommend improved policies and procedures for information systems (IS), based on an evaluation of present systems. Evaluations were made on the basis of 26 criteria, divided into three categories. A sample of the criteria is presented in the table below together with the categories used:

Table 18. Categories and Criteria for Evaluating I/S (Alloway and Quillard)

Strategic activities

- Involvement of senior user managers in I/S policy formulation and evaluation
- Responsiveness to user needs
- I/S strategic planning and allocation of resources to key business areas

Technical activities

- Technical competence of the I/S staff
- Improving new systems development
- I/S support for users in preparing proposals for new systems

Operational activities

- Efficiency of hardware utilization
- Hardware and systems downtime
- Availability and timeliness of report delivery to users

The survey consisted of administering questionnaires to managers of I/S and managers of users of such systems. The authors summarize their findings as follows: "The results suggest that the I/S function has not succeeded in the past, for whatever reason, in improving the performance of those things judged to be important by both I/S and user managers."

5.2 INTRODUCTION OF OFFICE AUTOMATION INTO ORGANIZATIONS

Luke (87) notes that when new technology or equipment is introduced into an existing operational environment, it is necessary to pay special attention to the way that we manage the introduction, implementation, training and feedback of the new system. This care is needed to ensure that the staff is motivated and informed, positive and cooperative. Of primary importance is the need to plan and communicate with all of those who will be affected by the change. Among the goals that should be pursued are:

- Do it right note experts' advice on how/where to install new technology;
- Keep up the motivation and morale of the staff during and after the changes;
- Counteract the usual resistance to change and fear of learning new things (the potential for failures),
- Create excitement about the capabilities and potential of the new equipment;
- Enlist enthusiasm and creative ideas for how best to bring up and use the new systems;
- Ensure full cooperation of all of those involved, from top management to the support staff;
- Keep all of those involved fully informed; and
- Keep the routine work going during the transition.

Exxon initiated an OA program as a result of technological opportunities and rising costs of office operations with constant productivity. Dickensen (88) describes the steps used by his organization in initiating OA.

- The first step is to learn as much as possible about OA technologies without becoming immersed in details. The focus was on the functional application of technology, using a system approach. A concept for thinking about OA was then formulated (table 19).
- The education of the management of an organization is an essential part of a successful OA program. Meetings to explain the effort, and followup written information are essential parts of this process.
- Tools and techniques must be developed as a means to systematically study current office operations and suggest means of improving them by using OA technologies.
- As new systems are installed in an organization, they must be tested and evaluated to provide information which can lead to future improvements.

° Finally, the group responsible for developing OA assists in the implementation phase of OA and consults with users as required to ease the transition from the traditional office to the automated one.

Table 19. Seven Components of the Business Communications Systems. (Dickenson)

1.	Creation	The act of thinking, analysis, generation of ideas and words.
2.	Capture	Putting the thoughts and words into some processable medium-writing, dictation, etc.
3.	Entry into/editing by a processor	Keyboarding
4.	Expansion/materialization	Printing, copying, microfilming
5.	Distribution	Mail, cable, TWX, telex, facsimile, electronic mail
6.	Indexing/storage/retrieval	
7.	Disposal	

McNurlin (18) suggests that the implementation of OA is best achieved by a series of short steps, consistent with a long term plan. Each project should be cost-justified and make use of previously tested technologies. After the new system is running smoothly, additional features can be gradually introduced. Finally, when an advanced system is being installed, it should be located in only those departments where the operating management gives full support and cooperation to the effort. A general approach to implementing OA in large or small organizations is then recommended.

An OA team is formed, and lists the opportunities for OA to make a significant contribution to organizational effectiveness. The list is based upon a study of the available technologies, the organization and examination of critical success factors (CSF) - the key areas of organizational performance where things must go right. Information needs are then identified. One requirement is the ability to monitor the flow of work by means of milestones. Information about the past, the present and the future, must be stored. Managers need the tools to communicate electronically with other people, and with data bases to retrieve information. The office systems in place must be described and their effectiveness assessed from a functional standpoint, and in terms of costs. A study is then made of the activities of the target group to suggest improvements.

Questionnaires, activity diaries, personal interviews, and samples of files and tasks are used in this study. The final step is to forecast how organizational goals are likely to be met in the future. Among the issues to be examined are human, economic and organizational ones. For example, to forecast whether: employees are likely to require the same work environment; they will be housed in one or more buildings; teleconferencing is likely to influence travel requirements.

Lodahl and Meyer (89) describe six "pathways" to office automation, which have been used by various organizations embarking on this course.

1. Administrative Typing. The most commonly found experience is the company which takes the initial step to office automation by focusing on word processing and administrative support activities. The systems purchased to accomplish these purposes were obtained with the aim of saving money on text production by improving the efficiency of secretarial and clerical personnel. To justify the capital investment initially, the philosophy led to organizational disruptions resulting from the change in the traditional working relationship between managers and their personal secretaries. At present, with the reduced prices of word processing equipment, a more decentralized approach is possible, maximizing the effectiveness of the organization, rather than that of the equipment.

2. Administrative Filing. Filing space is very expensive (estimated by the authors at $8 to $25 per square ft per month). Paper files are also difficult to access and often grow without any administrative control. A growing trend exists to make greater use of microform and digital electronic storage techniques as a substitute for paper files. It is estimated that the compression factor for digital media is 300:1 and for microform 1,500:1, when compared with paper storage.

However, regardless of the media involved, records management requires a great deal of analysis of the contents of files before an effective system can be designed. That is, the nature of the files must be determined, where copies are maintained, how they will be used, and their expected lifetimes must be specified - all of which requires a considerable involvement by the user of the information. In short, while payoffs may be considerable in using microform and electronic storage, implementation costs are also significant.

3. Telecommunications. Under this heading, the authors concentrate on the development of computer-based information systems (CMBS). This system enables the user to enter a message by means of any computer terminal and address it to one or more individuals or groups. The message is instantly delivered to the recipients file space, where he/she receives notification that a message has been received. The systems are designed for direct use by professionals and managers, and are of particular value to project teams who regularly communicate across multiple time zones. Users speak of the benefits from more frequent contact with peers, resulting in closer collaboration efforts.

4. Information Gathering. It is the author's claim that vast data bases are now available to managers and are frequently not well utilized. These informational resources consist of data internal to an organization and those available on a time-shared basis, ranging from current news to professional and journal publications. The proper use of these data bases however, frequently requires considerable expertise in the use of search strategies, requiring training or the use of an intermediary familiar with such activities.

5. Professional Writing. Text writing tools to be used by managers and professionals provide a management work station approach to office automation. They typically are considered as extensions of the word processing activities, with additional features such as structured files, calendar and reminder features, formatting and programming capabilities. Ease of use is an important consideration for the design of executive work stations.

6. Decision Support Systems. These systems combine data bases, models, statistical analysis, and graphic tools which are under the control of a user-oriented interactive command language. They are of particular benefit to those organizational areas requiring analytic work- planning, finance, marketing. Much of the benefits of these systems is the direct user involvement in the design and implementation process, where specific alternatives can be considered and analyzed.

5.3 PROBLEM AREAS - OA

Driscoll (80) notes that when word processors (WP) were first introduced into offices, that the results were often dissapointing. The output was of inferior quality; they generated little cost savings and encountered widespread resistance from users. These early WP systems sought savings only from more efficient typing, neglecting the greater potential savings by systems designed for use by managers and professionals. One of the major reasons for the shortcomings of these systems is attributed to the lack of involvement at the planning stage of the ultimate users of the equipment. Driscoll points to three major shortcomings of past and currently proposed OA approaches:

- In the rush to install new hardware, vendors and users have neglected a careful diagnosis of the critical function of office work.

- Mechanization often neglects the human side of the enterprise. Little attention is paid to the need for a "social redesign" of the office to facilitate the use of new equipment.

- Current mechanization programs neglect the body of information from management and ergonomic sources, which deal with organizational changes.

Hammer and Kunin (90) suggest that one of the major obstacles faced by those advocating office automation is the problem of measuring managerial and professional productivity as a means of justifying these systems. They indicate that the analysis and measurement of such activities as communicating, writing and reading reports may or may not be important job components. For example, is an executive more effective if he can generate eight memoranda in a day instead of the five that were possible before automation?

In their view, the most successful applications of OA systems have been at the department level, to solve specific and well defined problems dealing with business operations. They stress the need to introduce strategies and develop the means to evaluate changes after the introduction of new systems. This orientation is based upon the view that OA achieves its greatest potential by simplifying tasks and eliminating unnecessary steps in performing a job, and by solving problems which were not amenable to solution before the OA tools became available.

Since paper is so much a part of our everyday lives we tend to underestimate its importance, especially as it impacts our work habits in the office, according to McIntosh (91). Too frequently, an electronic system is designed to offset the shortcomings of a bad paper system, instead of determining whether the existing paper based system can be substantially improved first.

Both paper and electronic systems require structured and effective management of information. In an automated environment, the classification and indexing of information must be far more precise than most systems in use today. The value and life cycle of information are among the most important attributes that must be classified as prerequisites to automation, if outmoded systems are not to be transformed into electronic systems which are also inefficient.

Eichorn (92) summarizes a number of important problems identified by major users of office automation:

- Difficulty in getting employees interested in the system.
- Underestimation of the organizational problems associated with the introduction of such systems.
- Unfriendly user interfaces of many of the systems on the market.
- Lack of suitable opportunities for exchange of information among vendors and users.

5.4 PLANNING FOR OA

Eichorn suggests that for a company to be successful in the future, the staff would have to interact, and be part, of an information control system. Such a system must be responsive to:

- The dynamics of the organization.
- The procedures and systems employed by the organization.
- The automation technology - likely to be the least important factor contributing to success, since the pace of technology has historically

outpaced the rate at which organizations have been able to assimilate change.

Riley (93) emphasizes the need to examine the total operations of an office-organization, functions and products, before acquiring equipment representing the latest technological advances. He notes that all offices have in common the need to process information, but they differ in terms of the purpose for the information, the types of data needed and how the information is to be processed and ultimately presented. Among the questions to be posed should be the following:

- Is the information intended to support decision making, promote a product, implement plans or communicate policies?

- Is the information in the form of narrative or data?

- Are the documents stable or do they have to be updated regularly?

- What volume of documents is produced?

- How often are they used?

- How long do they have to be kept?

With respect to document retrieval (from micrographic storage especially), he points to the need for sophisticated indexing and retrieval systems.

Lieberman et al. (21) developed an office system planning framework as in figure 15. This approach is directed to the needs of organizational management.

Office automation is said to be most successful in systems designed to help carry out specific office functions or processes (94). A clear understanding of the functions of a group considering automation is therefore a prerequisite for an organization embarking on such an effort. The highest potential for successful automation resides in an organization having a combination of the following characteristics:

- Large volume of data or information processed.
- Operations involved uniform or similar repetitive processes.
- Complex calculations.
- Persistent backlogs.
- Difficulties in scheduling or resource allocation.
- Continuous need for rapid information retrieval and/or distribution.

Alloway and Quillard (86) suggest the following priorities for action to improve future I/S systems (table 20).

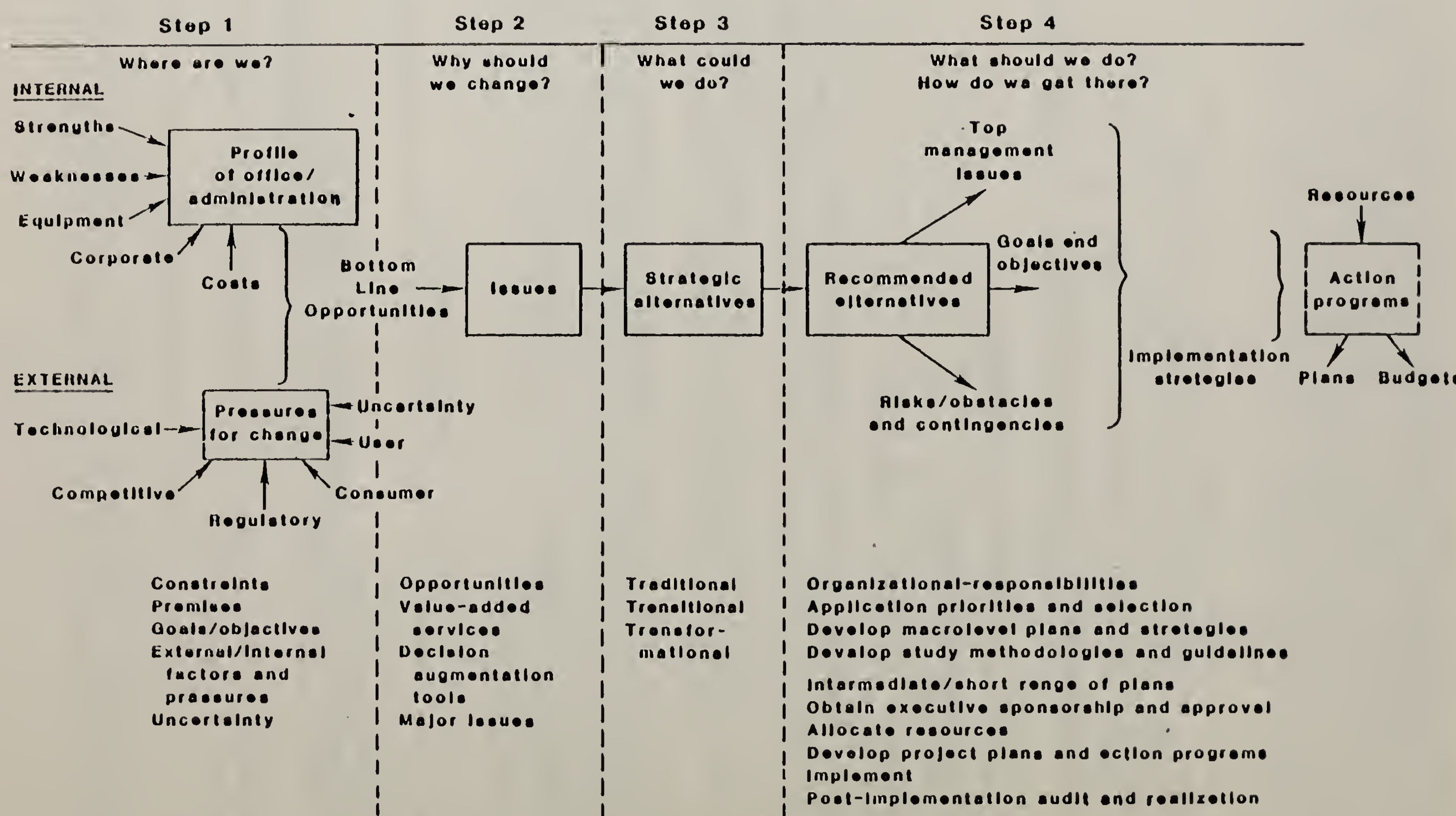


Figure 15: Office systems planning framework diagram (Lieberman)

Table 20. Priorities for Improving I/S (Alloway and Quillard)

<u>Top Priority</u>

- Obtain greater responsiveness to user needs.

<u>Second Priority</u>

- Develop more analytic systems.
- Improve communication with managerial users.
- Develop training programs for users in general I/S capabilities.
- Employ user oriented systems analysts who <u>know</u> user operations.

<u>Third Priority</u>

- More effective I/S strategic planning and allocation of resources to key business areas.

- Improve new system development approaches (time, cost, quality, disruptions).

5.5 CASE STUDIES OF OA

Luke (87) cites an example of the introduction of a new information processing system at Xerox. A company-wide survey of users was administered to determine the information production procedures used. A plan was then prepared indicating the proposed locations of the new machines and an installation schedule. Meetings were then held with the managers of the operating units scheduled to receive the new equipment. The general approach for implementing the system was described, as well as the operating characteristics and the concepts governing its installation and use. Volunteers among the groups were solicited to pilot test the installation of the system. Meetings were then held with the support staff, covering the same subject matter as in the previous meetings. In both sets of meetings suggestions were sought from the staff, and in some instances the plan was modified in accordance with their recommendations. An implementation team was then established to guide the work of the pilot-test groups and evaluate the results. Training of the operators was an important component of the plan. The training advocated covers the complete system, including the logical foundation for its design, not just how to "push buttons".

The in-depth training was designed to enable users to use the system in creative ways and provide some know-how to get out of trouble when malfunctions occur. The trainers should be professionals, not users who have been previously trained. Training should be carried out at all organizational levels, not just for clerical operations, if the automated office is to come into being.

McNurlin (18) cites the experience of CITIBANK, N.A. as an example of the planning and implementation of an office automation system. In 1975, CITIBANK decided to broaden the responsibilities of the services management group. In addition to providing assistance to other departments in the installation of word processing they would now also determine how office technologies could be used to aid management.

They initiated a study to determine the nature of the work that their management personnel performed. They found that managerial activities were very similar for all job types, but communications requirements often differed considerably from job to job. For example, some groups had a great deal of contact with customers, others held many internal meetings, and still others traveled a good deal. The telephone use as well as the flow of internal and external mail were all quite different from group to group. As a result of this study, it was determined that a new communications network was required to meet the diverse needs of the various groups studied.

McNurlin described the first step of OA as follows:

> "The first step toward implementing the corporate network was the installation of sixteen prototype systems. These systems are stand-alone units, each shared between a manager and a secretary. They are linked using 1200 bps dial-up lines with each system automatically sending and receiving messages. Each system consists of a 24-line CRT display terminal in the manager's office, and a similar display unit, an impact printer, a floppy disk unit, and a mini-computer in the secretary's office . . . The software for the system was written by Citibank. The system provides word processing, message distribution and filing capabilities."

CITIBANK then evaluated the system and identified several problems. Many managers didn't want to use the system because they did not want to type. They also found the system difficult to use, because of the need to learn and remember the required procedures. Other comments made were that function keys were preferable to typing in commands, and that managers wanted to see full pages of text displayed at one time. Finally, objections were made to the appearance of the system - with the suggestion that it ought to be suitable to the decor of the office.

Mumford (95) describes the process used to introduce automation into an office environment in which a central planning role was given to the users of the system. The clerks responsible for preparing purchasing invoices in a large engineering firm worked together with professional systems analysts to restructure their work environment. The clerks were involved in diagnosing their own requirements to attain job satisfaction, and to identify problem areas which led to inefficiency on the job. As a result of this effort, alternative forms of work organization were formulated aimed at greater efficiency and job enrichment. Problems encountered in the design process centered on factors of interpersonal relationships and trust - e.g., the clerks needed to be convinced that management did not have any ulterior motives in this effort. The study was conducted to be successful in meeting its goals.

Achieving the office-of-the-future will be difficult unless organizations change to accommodate new needs, in the view of Holmes (96). In the past, new systems and technologies have often led to new departments - separate and distinct organizational elements, e.g., data processing. However, well designed information management systems do not stop at organizational boundaries. For example, payroll, personnel records and employee benefits are now often combined with general accounting functions. This development has important implications for the autonomy of each of these departments with a given organization, and consequently for the individual employee working in these departments.

An effective office automation system requires organizational elements to work together in harmony in a non-parochial way. Holmes suggests the formation of task forces, with representatives from all affected departments to design and implement office automation systems. The best person to serve as chairman for the task force would be a key user, not merely a member of the user organization who can be "spared".

5.6 RESEARCH NEEDS

While general agreement exists about the need to measure productivity, it has been very difficult for researchers to develop appropriate and sensitive indicators for such measurements.

Productivity is typically defined as the relationship of outputs to inputs. In practice many output and input factors are not included in these computations. Inputs and outputs are also defined in many ways. For example, Slagle et al. (97) note that inputs can be measured by (1) the number of personnel needed to do a job, (2) the number of pieces of equipment to do a job, (3) the dollar cost of personnel, (4) the dollar cost for all inputs such as labor, equipment, space utilities, supplies and maintenance. The inclusion of all inputs is suggested as an approach to "total factor productivity", but it implies the total outputs should be valued as well. In an office automation study, these outputs would include factors such as quality and quantity of output, response time, morale, personnel turnover, and the quality of the office environment.

Few thorough studies have been completed dealing with the impact of word processing on the productivity of secretarial and clerical functions Slagle et al., conclude after a literature review of the topic. The authors reach the same conclusion in their examination of professional and managerial tasks. They also point to the unique quality of each office system and organization as a result of a combination of the employees, managerial style, organizational climate and the nature of the work and methods used to accomplish their work. Among the factors which influence productivity are:

- The mission of the organization.
- The volume and kind of workload.
- Work methods and procedures.
- The outlook of the employees toward technological change.

° The expectations of the staff regarding management & organizational climate.

° The approach used to introduce automation and training.

Keen (98) notes that it took the data processing field almost 30 years to discover that the introduction of technology into an organization can have a profound effect on it. However, while data processing (DP) did impact the specific job functions of some individuals, most people in an organization had little direct contact with DP. The advent of OA on the other hand has much widespread organization implications which are only now receiving some serious attention by researchers. Keen's paper summarizes the responses of researchers and practitioners of OA to the following questions:

° What are the positive aspects of office technology (OT)? The negative? Which will win?

° What are the implementors and sellers of office technology overlooking? What research is needed here?

° Where will applications have reached five years in the future? What will be the major changes to organizations and to individuals?

° What are the key issues for research?

° What conceptually and empirically do the fields of social science, management and even liberal arts offer to the study of office technology and people?

The responses indicated that the primary need is for methodological research, examining issues of <u>how</u> to study work processes and <u>what</u> aspects should be explored. Another theme was the need to pay more attention to behavioral and organizational issues rather than solely concentrating on technological ones.

The research agenda compiled as a result of the study contained the following six subject areas:

1. The study of work

2. The impacts of technical change on the individual and the organization

3. The criteria for design of OA tools

4. A suitable conception and measure of productivity for OA

5. The knowledge base needed for effective education and

6. A deeper, broader and more realistic picture of the relationship between people and technology and vice versa.

6. OFFICE INFORMATION SYSTEMS

Martin (23), Hammer (99), Connell (11) and countless other OA experts have characterized the office as a setting for developing, processing, and disseminating organizational information. Strassman (100) makes the further point that in the office-of-the future, information will have to be handled electronically in ways that reduce labor requirements, since they already constitute a major organizational expense and have been steadily increasing. The trend away from an almost total reliance on paper as an informational medium toward electronically based systems, importantly influences office design in many respects.

For the forseeable future, office design must accomodate informational systems that rely on paper and electronic media, and increasingly, microfiche systems are being used as well. A worker at a single workstation often is required to deal with information in all three of these forms during the course of a workday. The lighting designer who must provide a system whch accomodates the visual needs of an office worker who accesses information from a VDT screen, paper copy, and a microfiche reader, is faced with a formidable challenge.

The increased use of VDT based workstations, and the linking of individual stations into networks has already changed the appearance and functioning of many offices, and as noted earlier, most OA experts anticipate an acceleration of this trend. The workstation is the place where the information and telecommunication technologies have come together to provide the opportunity to restructure to restructure the way that office work is performed by all people engaged in office work. The individual at a workstation is becoming increasingly autonomous in being able to perform many office tasks—having the ability to access data bases and peripheral devices by electronic means. This increasing degree of independence from other people in the office (e.g., support personnel), has already transformed the workplace as a social setting in many instances, in ways that are only partially understood, and only now are beginning to be investigated by researchers. Office designers are faced with a major challenge to provide a setting where the shared purposes of the staff and the organization can be identified for individuals who are capable of performing many jobs with litle or no interaction with their associates.

Information is a corporate resource, and should be looked upon as the product of the office according to Connell (101). While important, it is hard to place a value on information because it is far different than traditional products. Managers need to know about information technology developments. Data processing was an outgrowth of the punched card equipment in the 1950s and the electronic computers in the 1960s. WP started with the typewriters with magnetic tape storage in the 1960s. The office today is organized around technologies as they have developed historically, and their separation has been institutionalized. This is now changing because the distinction among technologies is being blurred, and the advances in telecommunications now permit the interconnection of previously separate technologies into networks.

The minicomputer exemplifies the change which moves the computer power out of the hands of the information specialists and the data center into the office.

Many of the DP systems in use today require experts to maintain and update programs - a very inefficient system.

In the development of conventional information systems, users propose a system to accomplish a given function. The information services activity then conducts a feasibility study and reviews the findings with the users. A system is then designed, which is then received and finally accepted by the using organization. In this approach, the views of the systems designers predominate, with the users having at best a secondary role, and a limited understanding of the decisions being made. As a result of this process users are often dissatisfied with the system provided to them, and consequently underutilize it.

Connell suggests an evolutionary approach which centers on the system user (figure 16). The user is responsible for conducting the design effort and the system analyst's role is one of a catalyst for the design team. The emphasis on the user is to ensure that the system is understood by him, responsive to his needs, and that he has an important stake in the success of the system. In the design, special attention is given to the user interface - the design element most influential in determining the user reaction to a system. The criteria used to evaluate the final system is also established by the user, in terms of its usefulness and general acceptability rather than its technical elegance, often sought by the systems designer.

Documents may be originated internal or external to an organization and may be in one of many forms, from a telephone message to a formal report. For most intra-organizational documents, initiation and word processing may be combined into a single step. Once a document is in digital form, it is disseminated electronically to recipients, and/or filed for subsequent retrieval by those requiring the information. Developing effective office information systems for organizations requires:

- Determining appropriate formats for typical office documents.
- Formulating improved indexing systems for corporate documents.
- Identifying those who should be responsible for document indexing.
- Developing efficient search strategies for document retrieval.

McNurlin (18) suggests that field studies should be conducted in a variety of organizational settings to study the mechanics of document processing in offices. She also advocates the development and testing of several indexing procedures to determine their effectiveness of system performance.

The need for a company-wide data base is being increasingly recognized by many organizations, according to Nolan (102). It is based upon two premises: The data in computer storage is an independent resource, not merely the raw material to be manipulated by computer programs. These data can be structured and managed to enable them to be an important resource for the organization as a whole, especially on an ad hoc basis - where they would be especially responsive to requests by higher levels of management.

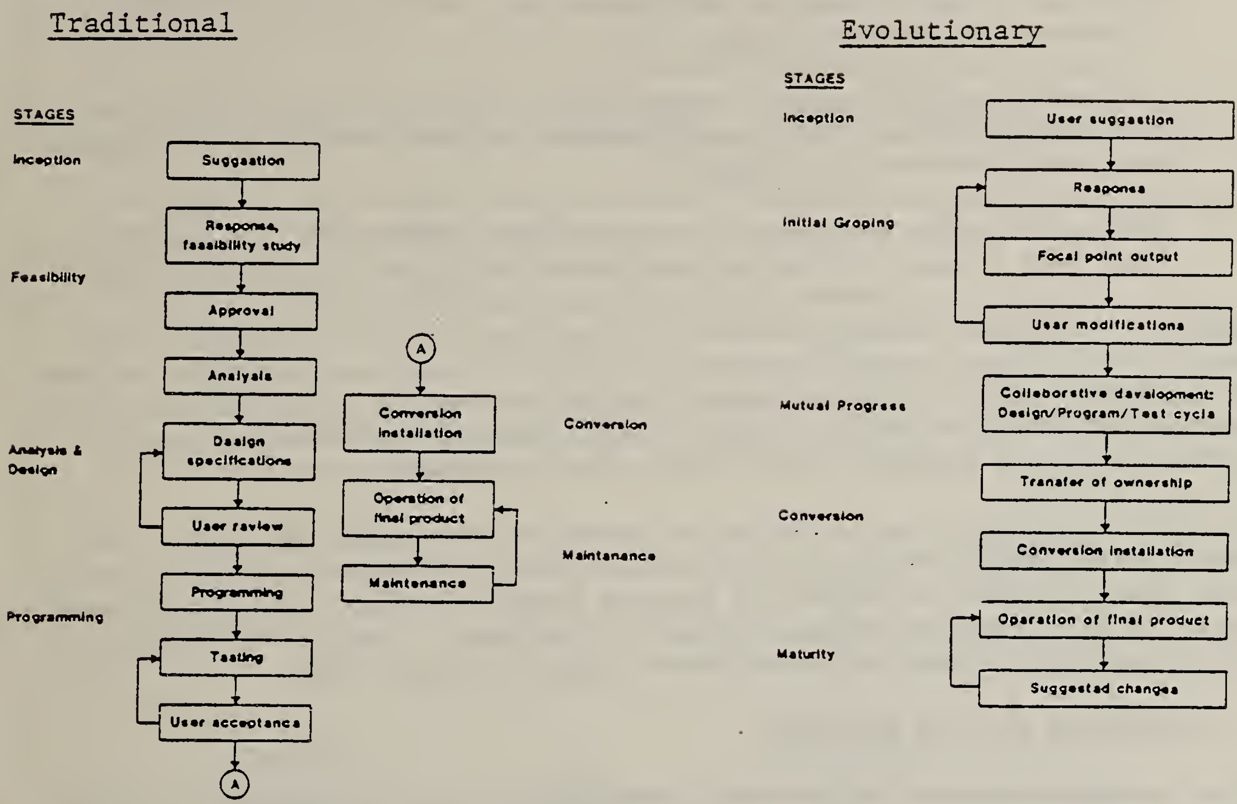


Figure 16. Traditional and evolutionary design (Connell)

Many of the current data bases have been developed independently by working units in an organization to meet particular needs. The data are often quite fragmentary as a result, and compatibility across organizational boundaries is quite rare. This historical development of data files has resulted in several problems:

- Files and records are often duplicated to meet particular needs. The updating of such files is burdensome and costly, and it is inefficient to maintain redundant files.

- The advantages of the new technologies (reduced costs of data storage) are not capitalized upon, and programming requirements are increased when modifications are needed.

- Middle and upper management cannot readily obtain the information that they need because of the existing data structures and organization.

In general - the more closely related the functional use of the data, the easier it is to design a non-redundant integrated data base comprised of computer readable data. Key task identification has been an effective strategy in developing computerized data bases, when organized in accordance with commercial software packages (KEY TASKS = Top Management needs).

Connell (101) observes that information needs are not being met today, not because of the lack of data but from an overload of irrelevant data. A major problem today is that no individual manages today's office, rather assignments are made in accordance with departments or functions. The office is task centered instead of being oriented toward organizational goals.

6.1 INFORMATION SYSTEMS AND TYPES

Computer message systems for managers constitute a major challenge to systems designers since management work is characterized by its unpredictability and variety, according to Newman (103). No body of data is available to help structure a job, or its informational requirements. Furthermore, by its very nature a management job in one organization is likely to be very different from a "similar" job elsewhere. What a decision maker needs is the ability to manipulate pulate a continuously updated data base, to extrapolate trends and visualize information in various formats. This capability would require an interface that enables him to access all relavant information simply and in the same way - not requiring a good deal of specialized training in order to use the system.

One of the most important attributes of an automated office is the organization of a data base to enable all workers to have access to the information that they require. Clark (104) defines such a data base as:

> "a stored collection of integrated records used by two or more applications systems. It is intended to handle the data requirements in a dynamic environment, and facilitate planned and organized change. To facilitate change, it uses principles of data redundancy and centralized coordination and control over the physical resource through a data base management system (DBMS)."

6.1.1 Data Base Management Systems (DBMS)

While there is no generally accepted definition for a DBMS, Clark suggests that such a system consists of:

- User requesters of data - read-data, modify-data, add-delete-data.
- Software to retrieve, write, or modify data.
- The data base which serves as the physical repository of data.
- An Applications program, which writes codes to process user requests.
- The control of information resource by generating data descriptions and selecting user access policies.

Figure 17 illustrates the DBMS operational environment.

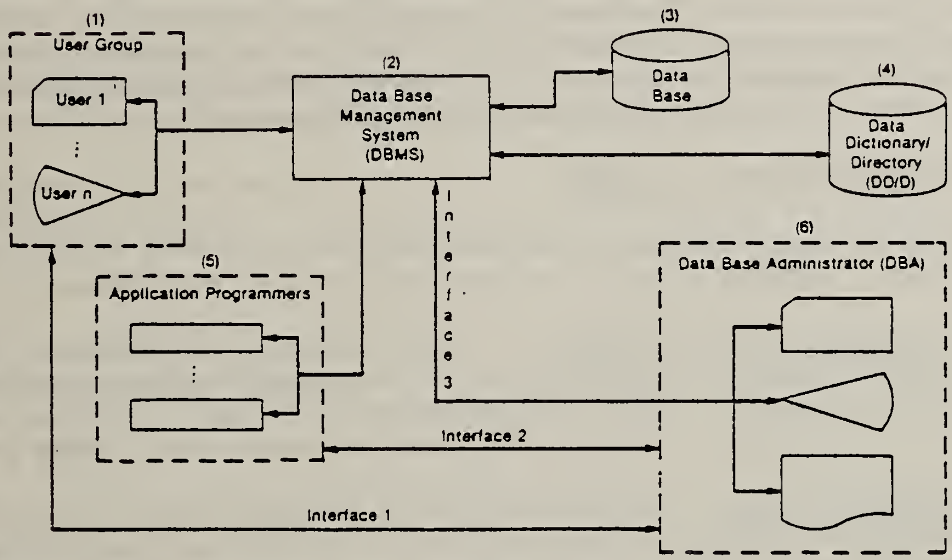


Figure 17. DBMS operational environment (Clark)

6.1.2 Decision Support Systems (DSS)

Morgan (105) believes that decision support systems (DSS) can play an important role for professionals and managers in the automated office. These systems provide direct input and feedback in the decision making process. For the most part the available systems can operate on terminals used for word processing and electronic mail. They enable a manager to examine a range of alternatives in making a decision, or examine the effects of a range of variables more effectively than by using manual or batch processing methods.

Managers seldom need access to individual transactions which occur in an organization. Rather, they want to see aggregated sets of data describing operations and functions. Initially, management information systems (MIS) were developed to fill this need; they focused on historical data and information generated within an organization. The advent of DSS demonstrates the shift from historical data requirements to projections that can be used for planning purposes.

DSS, unlike other information systems, must be designed for a specific user in a specific decision situation. It is rare that a DSS will be used in the same way by a group of users. Under these circumstances, the DSS must be capable of being built quickly and inexpensively. The heart of any DSS is the model which the user builds of a given decision problem. This model may be analytical, tabular or a simulation. The ease of entering and changing the model is of central importance since the user is not likely to be an expert programmer. Since one major purpose of the DSS is to permit many alternatives to be examined, good output mechanisms are required, especially graphics.

6.1.2.1 Building Blocks of a DSS

Morgan indicates that there are four key building blocks of a DSS, making use of generalized programming procedures and application generators.

1. Interactive user interface. Dialog managers are employed, which are standard subroutines which are called upon for input/output functions at the terminal. They list parameters such as: question to be asked, type of response desired, reference pointer.

2. Database manager. Brings external information into the system, saves and restores information from one run to the next, and links different application modules, and provides ready access to raw data.

3. Modeling system. Enables users to select from a variety of models.

4. Output generator. Data can be presented in a number of forms, depending on the nature of the information used and the decisions to be made. An important attribute is the capability to deal with "what if" type of questions by demonstrating the effects of changing individual parameters.

The author suggests that a DSS be implemented by starting with a set of prototype menus, and determining whether the user can go through them in a logical sequence. The system designer must work closely with the user to clarify particular needs and desires, resulting in a rough model that should then be tested by the user before being implemented.

Keen (106) describes a DSS as a means to improve the effectiveness of managers by supporting the process used to make management decisions. The DSS neither automates the decision process nor imposes a sequence of analysis on the user. It is characterized by the following:

- It is used for non-routine (ad-hoc) problem solving.
- It often addresses "what if" questions.
- It does not result in "correct" answers, but clarifies the tradeoffs that are available to the manager.

Table 21. Potential Benefits of DSS, and the Ease of Measuring them (Keen)

	Easy to Measure?	Benefit can be quantified in a "bottom line" figure?
1. Increase in number of alternatives examined	Y	N
2. Better understanding of the business	N	N
3. Fast response to unexpected situations	Y	N
4. Ability to carry out ad hoc analysis	Y	N
5. New insights and learning	N	N
6. Improved communication	N	N
7. Control	N	N
8. Cost savings	Y	Y
9. Better decisions	N	N
10. More effective teamwork	N	N
11. Time savings	Y	Y
12. Making better use of data resource	Y	N

As computer users operate more of their own equipment they want control of how and when their activities are performed. This orientation has important implications for Management Information Systems (MIS), against centralized control, toward a distributed systems approach, and increasing end-user responsibilities; this trend is especially true for organizational units with unique short-term informational requirements.

The trend to centralization has led to a number of problems:

- Isolation of the MIS activivity from the end-user and incomplete understanding of his needs.

- A great deal of time and money expanded in developing and maintaining a centralized system.

- Bottlenecks occurring in central system, leading to the purchase of microcomputers to deal with specific uses.

Advantages of Distributed Systems:

- Less costly to purchase and operate; can be tailored to specific needs of operating groups.

- Communications costs less because of networking; less need for leased lines.

- Avoidance of bottlenecks associated with centralized facilities.

Organizational Impact of Distributed Systems:

- User management will have to be somewhat knowledgable about system.

- User will be responsible for daily operation of system.

- User will have to spend time learning how to operate system; increased job responsibilities.

- Diminished need for centralized systems.

Robey (107) examined the impact of computers on management personnel by surveying managers in eight organizations located in five different countries. The respondents were asked questions about the effects of automation on the factors listed on table 22.

Table 22. Office Performance Factors (Robey)

- Enriching factors - which reflect intrinsically satisfying aspects of work.

  1. Degree of complexity in the task
  2. Number of problems recognized within the task
  3. Possibility of developing new ideas or methods
  4. Feedback on decisions

- Structural factors - which reflect rigidity and routine in the task.

  1. Degree of routine of the task
  2. Standardization of codes or terminology in the task

- Load factors - which reflect work pace and its variations

  1. Work pace in the task
  2. Variations in work pace in the task
  3. Work load within the task

Robey found that managers were enthusiastic about the new technologies because they were perceived to improve their job performance. A large percentage of users believed that their jobs were enriched because of the increase in time available for creative activities, and for the opportunity to deal with more complex and demanding tasks; and opportunity to deal with difficult challenges. The additional structuring of tasks required by computer control was not perceived to be a disadvantage, because this standardization freed the managers to apply new ideas and methods to a wider variety of problems that they encountered.

6.2 DISTRIBUTED DATA PROCESSING

Distributed processing refers to the division of logically related processing functions among geographically dispersed computer systems. Instead of one computer performing all of the jobs, physically separate mini and/or microcomputers will each perform part of the processing function. Feidelman (108) evaluates DDP as follows:

The advantages of DDP are:

> Design modularity which permits computer power or peripheral capability to be added or subtracted in accordance with the needs of the user.
>
> System Reliability is enhanced because a breakdown is not catastrophic, that is, only part of the information is lost.

User Interaction is facilitated because "user friendly" languages are more often employed than is the case with centralized systems.

Disadvantages of DDP:

- ° More sophisticated control programs are required.

- ° Current MIS are designed to support central data bases. A new technology is required to provide updating capability and maintain the integrity of the data base.

Four phases have been identified by Fiedelman in establishing an integrated DDP system:

1. Remotely located data entry/processing terminals are satellites to the centralized computer. The central computer takes on the responsibility for management requirements.

2. Minicomputer systems perform specific DP functions and are satellites to the central computer.

3. Professional work stations with microcomputers can work both independently and as terminals to the main computer.

4. A central computer with a network of other computers to perform OA & DP work.

Several methods are suggested by Withington (109) to cope with the advent of distributed data processing (DDP). Programmers, systems analysts and information specialists should work with professionals and managers who want to become knowledgable about data processing. New and limited experimental DDP systems should be developed as needed, and findings should be shared throughout organizations after assessments of the systems are made. Experimental systems should follow existing standards and procedures to the extent feasible, while permitting a degree of flexibility and innovation to enable improved systems to evolve. A balance must also be maintained toward central guidance and the encouragement of creative ideas from lower levels of the organization.

The success of experimental systems is thought to be primarily dependent on the motivation and preference of the end-users, and they should be given as much responsibility as possible in system development, consistent with general organizational guidelines. Failure of some new systems must be tolerated to encourage innovation. Withington summarizes the potential advantages and disadvantages of distributed responsibility as follows:

6.2.1 Potential Advantages of Distributed Responsibility

- ° Disperses expertise to users and increases technological awareness throughout an organization.

- Innovation is fostered, while some central control is maintained.

- Internal guidelines can be upgraded as a result of new experiences.

- It promotes better communication across organizational units.

- It encourages the use of common procedures because of substantial user involvement in their development.

6.2.2 Potential Disadvantages of Distributed Responsibility

- Proliferation of many independent and dedicated systems.

- Time spent on meetings to develop consensus on new systems.

- Data processing professionals are required to perform new functions, e.g. teaching.

- The process is difficult to control centrally.

- The approach assumes little centralized long-range planning.

6.3 INFORMATIONAL ANALYSIS FOR COMPUTER USE

Kunin (110), in a fundamental paper, indicates the need to develop a language tailored to describe office functions. He starts with the premise that a structure exists in an office. A office is then described as a system which includes space, equipment, information and people. It has a particular mission - a set of goals which may be specified. The activities of office workers should be designed to effect that mission - and other system components exist to help the worker carry out that mission (e.g., hardware and systems). A second premise is that a high degree of commonality exists in the structures and activities of diverse offices, and that these commonalities can be expressed in terms of a formal language. A third premise is that office procedures are basically simple, but are often obscured by implementation details. Finally, documents are not the fundamental focus of office procedures, but rather are artifacts of the current implementation procedures. Kunin stresses the difference between functions and procedures in the following way. Functions manage objects while procedures change the state of objects, until the objects are no longer pertinent to the procedure. This object orientation enables the procedure to be defined as a sequence of desired object state changes.

Rosenbaum (111) developed a procedure of specifying the functional requirements of office automation users. Features and requirements of systems are organized under the following general categories:

- Text entry (document creation)
- Text output (document production)
- Text editing
- Text file, search and retrieval
- Document distribution and receipt

- Computer based messaging and conferencing
- Automated personnel and administrative aids and service

6.4 USER-SOFTWARE ISSUES

James (112) asserts that present computer systems are deficient in many respects but particularly with their responsiveness to users. He summarizes the problems as follows:

> "In a typical 'system' we have hardware controlled by some arbitrary 'machine code' which represents how engineers think about computing. Then we have an operating system, which attempts to disguise the collection of separately designed hardware components so that systems programmers do not have to spend all their time using special control codes for each component. Associated with this level is a control language which represents how a 'system' programmer has viewed the computing process. Finally, we have a collection of programming language compilers which impose a variety of models on the representation of 'solutions' to users' problems. Some parts of the programming language talk directly to hardware arithmetic units, some parts talk to a great hierarchy of operating system commands which insulate time-dependent operations of the input and output hardware from the programmer's consideration; yet again, other parts of the language modify the program itself to induce the repetition of nearly identical sequences of operation.
>
> There is an enormous variation in relative power of individual instruction in terms of what the hardware eventually does to realize each one, and enormous variation in the levels of language employed and the precision with which they must be specified."

James attributes many of the problems in OA to the failure to define clear objectives, which should focus on the ease of system use by the end-user. Current systems are designed for computer specialists for the most part. The user is faced with a foreign system, and documentation which is not suitable to the layman.

The end-user needs a system that is reliable, and one that provides feedback information as a result of user actions. The user should not be placed in the position of waiting for something that is not going to occur. In the event of a system breakdown, the user needs information indicating when it will be operational again.

Kling and Scacchi (113) observe that people who use computers are required to adjust to changes in computer systems and develop back-up procedures to use when automated systems are not available to them. Most solutions to computer use have focused on hardware improvements rather than dealing with the needs of the user and/or the organization. Computer use occurs in a complex social setting, defined by characteristics such as:

- Many people who are computer users expect that it will make them more effective in their work, although the computer is not central to their job responsibilities.

- The same data base is often needed by several different users who have conflicting views as to the data processing requirements for systems, and varying degrees of understanding about how much systems are used and operated.

- Data bases are often designed to serve managers with limited skills and knowledge concerning how such information is accessed.

- Computer based services are organized in many different ways within and between organizations.

Common issues in computer use:

- Users and computer specialists have different views about their work and how they are to interact with one another.

- People have conflicting views about the priorities and importance of various tasks.

- Conflicts often occur between users and computer specialists regarding who "controls".the computer capability.

C.P. Snow (114) made the point that two cultures are involved in modern society: the the scientific and non-scientific. Kintisch and Weisbord (115) suggest that designers and users of computer systems exemplify these differences, which can be divided into four categories:

1. Goal orientation. The computer specialist often sees himself as a member of a profession with transferable skills, which can be used by any organization. The users are primarily oriented toward the present employer and feels secure using present methods of doing their jobs. Change is a burden, and a threat.

2. Time orientation. Computer specialists often work in a long-term time frame, not requiring immediate feedback information concerning the effectiveness of his work. The user is more concerned with meeting short-term objectives in his day-to-day responsibilities.

3. Formality of organizational structure. Computer specialists often operate in a rather informal manner because of the requirement to respond to individuals at various levels in an organization. Most users operate within an organizational "chain of command".

4. Interpersonal orientation. Computer specialists work with abstract material, using formal language structures required by their computers. Users conduct business by means of verbal communications in many

instances, interacting with peers, superiors and subordinates in traditional ways; a "people" rather then computer orientation.

A team approach is needed to bring together these diverse groups. The leader of such a team should be knowledgeable about the subject matter being discussed, and hold a prominent organizational position.

Zuboff (116) observed that the primary goal of most computerized systems is to substitute decision rules or algorithms for individual judgement. This enables the development of computer programs which formalize the skills required to perform desired tasks. As the decision rules become more precise, more activities can be planned in advance and the less actual decision making is required at each stage of a process. A danger exists that decision rules will be based more and more on analytic procedures which do not deal with the real world complexity of many situations. Zuboff indicates that "the demands of the information system thus come to define the questions that are posed, the problems that are tackled, the meaning of valid information, and eventually the limits of knowledge itself." She suggests that managers will resist using information systems which appear to limit their freedom or increase the possibility of their work output being subject to measurement.

Zuboff agrees with the authors cited earlier; most professionals and managers now work in a relatively ambiguous environment, operating with incomplete information. The uncertainty of the limited information available enables them to freely exercise their judgements in many situations. This operating freedom is one of the major reasons for preferring professional work to the performance of routine and highly structured tasks such as those encountered on an assembly line. When the design of complex systems is highly centralized and computerized, the end user is likely to have little or no understanding of the comprehensive functioning of the system, or the decision rules or normative criteria built into the programs. As a result, it becomes difficult to challenge the validity of the information that they must work with.

The rhythm of work can also be profoundly affected by the availability of computerized information. In the past, when data printouts were available within 24 hours the users were quite content; now those who work with computers are often impatient when a wait of several seconds is necessary before the information can be accessed.

Finally, the computer terminal affects the quality and frequency of social interactions in the workplace, and their frequency. Instead of approaching a colleague for clarifying information associated with a problem, it becomes much easier to access a data base.

Bennett (117) describes a method of employing the concept of 'usability' as a means of evaluating the effectiveness of computer software from the standpoint of the end user. Usability refers to the ease of learning and ease of use. It is defined as a relationship among task, system and user to accomplish a given purpose (which can be objectively measured. Table 23 describes several categories of usability.

Table 23. Measureable "Ease of Use" Attributes Can Be Applied to Managing System Usability (Bennett)

LEARNABILITY

1. Training time for the population of intended users.

If an interface is "obvious" and fits smoothly into the user's pre-set or pre-conceived way of doing things, then the actions taken by the user will be "correct", and the training time will be short.

2. Learning time until a user can enter actions "automatically".

When tasks involve creative thinking, the person's limited cognitive

capacity makes it desirable that he or she can do any mechanical actions involved in the tasks without thinking about them. The person typing is most efficient when thinking of content, not the location of keys on a keyboard.

THROUGHPUT

3. Kind and rate of errors.

Errors can be a revealing indicator of where the "correct" action of the user (based on the "model" of the system in the user's mind) does not agree with the action expected by the system (the actual "model" as represented in the design of its hardware and software). The designer can use the pattern of errors as a diagnostic cue and choose to change the user's "model" of the system (through training) or to change the user interface (redesign of the system).

4. Time to recover from (user or system) errors.

Whatever the task, people will make mistakes. This is especially true for people who are infrequent users. An inhibitor to increased use of computer power is a concern that work will have to be repeated. Sure and rapid recovery from an error will be extremely important to people who entrust their creative work to an office system.

5. Warm-up time after being away from the equipment.

The wide variety of functions available through a computer terminal makes it unlikely that a user can always remember immediately how to get useful results. The amount of "how do I do that?" review needed is important for office workers who use a terminal irregularly or who use a variety of computer-based tools.

ATTITUDE

6. Feelings about continued use.

If a user's perception is that the system puts a physical or mental strain on him, he is not likely to be favorably disposed toward using it. In fact he may find active ways to prove that his use of that particular tool is not in his organization's best interest.

Stewart (118) discusses software requirements from the standpoint of dialogue requirements - which involves the sharing of knowledge by the exchange of information. An important characteristic of the communications medium is that it should not limit the ability of individuals to express complex and subtle ideas. The success of a dialogue also depends on the availability of suitable feedback, to signal when a message has been received properly or requires additional clarification to be understood. At times, dialogues require that withholding of some information which may make the message too complicated to understand. These general requirements also apply to human-computer dialogues, except the communications medium and the responsiveness of at least one participant are limited.

Crenshaw and Philipose (119) describe a friendly computer environment as one which meets the needs of users rather than violates them. Several such needs are:

- The need to have our expectations met. Machine performance should be predictable.
- The need for clear information.
- The need to succeed. Systems should allow for different levels of user experience and knowledge.
- The right to fail. Everyone makes mistakes, and computer systems should minimize the adverse effects of failure.
- The need for individuality. An environment which has no flexibility is constraining to the user.

6.5 INFORMATION SYSTEMS - SOME DESIGN IMPLICATIONS

The phasing out of many papers files in favor of electronic and microfiche technology has several design implications:

- Accessibility of electronically stored data is not dependent upon physical location.
- Electronically stored information requires emergency backup power to ensure that it is not lost during a power outage.
- The physical space required for data storage is likely to be reduced.
- The workstation design must accommodate the technology needed to access data stored electronically and on microfiche.
- Special facilities might be required to house the electrical storage system.

7. SOME TECHNOLOGICAL AND COMMUNICATIONS ISSUES

While technological and telecommunications developments are already influencing the design of offices, the "electronic revolution" has only started, in the view of most forecasters (4, 5, 11, 17). Buildings are now being designed to accomodate the electronic office, and the monitoring of building management functions (120). Workstations within buildings are being linked together to enable the sharing of information and other resources. Moreover, new spaces are being designed, which provide the capability to perform many traditional organizational functions, such as meetings, in new ways - e.g., teleconference rooms. Finally, the proliferation of electronic and electro-mechanical devices in offices designed to accomodate paper-based information systems, has led to environmental problems of noise and thermal discomfort for many office workers. Office designs are needed which accomodate the needs of both the equipment and the working staff. Moreover, these designs must be flexible enough to accomodate the changes that are inevitable - technological and organizational ones.

The driving forces behind office automation are the rapid advances made in technology and telecommunication. The diversity and volume of information dealing with these topics, as well as rate at which new products are being marketed, preclude any attempt to cover these subject areas in the present report. A limited number of issues will be addressed--those of particular relevance to the development of office design criteria.

An office system may be thought of as a collection of machines which are capable of being linked together to perform necessary office tasks. The goals of each office or business may differ from one another in significant ways, so the configuration and composition of systems show considerable variability. However, the architecture for office automation must provide for the connection of a number of machines which perform different functions, depending upon the particular requirements of a given office. Local area networks (LAN) will be the primary means of connecting office machines into a system within an office.

7.1 LOCAL AREA NETWORKS (LAN)

All of the advanced office technologies share the requirement to interface with one another by electronic means. Yet, one of the major impediments to office automation today is the lack of standardized systems (software and hardware) to move information from device to device, from system to system. As a result much of the available technology is incompatible.

In order to overcome this difficulty, several internally compatible systems have been developed. These systems are designed to access information from the "outside world" and also to facilitate the acquisition, transfer, analysis, and modification of data within an organization. These systems are often termed local area networks (LAN). Lowenthal (121) defines a LAN as a system where:

- Distances are measured in meters rather than kilometers
- Bandwidths are on the order of 1 to 20 megabits per second

° One operating unit (node) can potentially communicate with any other note at a given time.

In the view of Connell (122) the major advance of office automation technology in the 1980s is the advent of LAN designed to interconnect different machines, languages, and operating techniques into a coherent system. Networks are important because they provide the capabilities of advanced technologies to every office worker in every location. In the past, new technologies have been removed from the regular office into special centers. The specialized center approach has typified advances in data processing, word processing and reprographics. Furthermore, the capabilities of the technologies were made available through specialists in the given area, but not to the general work force. The physical separation of the activities was therefore reflected in the organizational structure of the company.

A second reason why networks are important in the view of Connell, is that individual technologies must be subordinated to organizational needs. As mentioned previously, offices have been organized into departments responsible for given technologies, with each one operating with considerable independence. The advent of networking requires coordinated planning which should include all office disciplines. This planning should be from the top-down and may result in a centralized or decentralized approach for office operations, depending on the nature of the organization and the viewpoint of top management.

While there is no single definition of a local area computer network (LAN) table 24 indicates the requirements of such a system in the view of Shoch et al. (123):

LAN is a development which responds to the need for integrated communication and information systems, but also reflects the technological marketplace. Saal (124) observes that as a result of the revolution in microchip technology the cost of a central processing unit (CPU) no longer dominates the development of a computer system. Instead, disc drives, printers and other electro-mechanical devices sometimes cost more than the central processor. The emphasis today is for rapid access to information by clerical, management and professional personnel. The personal computer is dedicated toward meeting this need by a one-person, one-computer approach. However, while sharing a personal computer is often not feasible today, the need still exists to share information and peripheral equipment which would not be cost-effective if employed by a single person (e.g. a high quality printer).

Personal computer networks preserve the independence of each work station while enabling users to share data and peripheral devices. Another standard feature of such networks is the ability to connect multiple networks by means of an internetwork link (gateway). Because of the multiplicity of technologies and communication protocols in use today, electrical and software protocols must be converted when passing data through these gateways.

Table 24. Requirements for a LAN (Shoch)

- Relatively high data rates (typically 1 to 10 megabits per second);
- Geographic distance spanning at most 1 kilometer (typically within a building or a small set of buildings).
- Ability to support several hundred independent devices;
- Simplicity, or the ability "to provide the simplest possible mechanisms that have the required functionality and performance"; [Crane and Taft, 1980]
- Good error characteristics, good reliability, and minimal dependence upon any centralized components or control;
- Efficient use of shared resources, particularly the communications network itself;
- Stability under high load;
- Fair access to the system by all devices;
- Easy installation of a small system, with gradual growth as the system evolves;
- Ease of re-configuration and maintenance;
- Low cost

Blackmarr (125) defines a LAN as an electronic communication linkage which does not require the use of any public communication facilities. He then discussed two major LAN issues:

7.1.1 Baseband vs Broadband

Broadband LAN uses one of several approaches often Frequency Division Multiplexing (FDM), to divide the throughput capacity of a LAN among several concurrent users. It is more sophisticated than baseband and therefore is more expensive. It has the advantage of providing a tremendous data throughput and is therefore suitable for high volume data transmissions. A baseband system is more limited in that it typically assigns its entire capacity to a single user for a brief period of time. It is especially suited to many low-volume users - typical of many present users of office automation.

7.1.2 LAN Circuitry

Many LAN use a data cable or CATV cable to connect network stations. An alternative approach is the use of existing telephone lines (twisted pairs), which is especially useful for offices located in existing buildings where it is difficult and expensive to string new cable. The major consideration is the communication capability needed, telephone lines being limited to approximately 56 Kbits/sec under ideal conditions.

Table 25. Typical Data Throughput Requirements (Blackmarr)

Application Type	Preferred Throughput Rate* (Bits/Second)
• Telex	55
• Low Volume Data Communication	4,800
• Moderate Volume Data Communication	9,600
• High Volume Data Communication	56,000
• Digital Voice	32,000
• Analog Voice	64,000
• Digital Video	3,000,000
• Television Grade Color Video	92,000,000

* Using current transmission techniques typical for each type of communication.

7.2 NETWORK CONFIGURATIONS

The newest (fifth) generation of computer technology is defined by Holzman (126) as an interlinked system of microcomputers which enable users to operate independently, while being able to directly access data within a computer network. Most local networks are designed to accommodate 200 or more microprocessor stations (nodes), separated from each other by as much as one mile. Each node operates as a personal computer and a communications system enabling data from diverse organizational units to be used by an individual working to solve a given problem or perform other office functions. Three types of configurations exemplify the structure of most networks:

1. The Star. This is the oldest arrangement, with a multiplexing device at the hub of the network. Microcomputers connect to the hub directly by coaxial cable or a telephone, using a modem. The problem with this

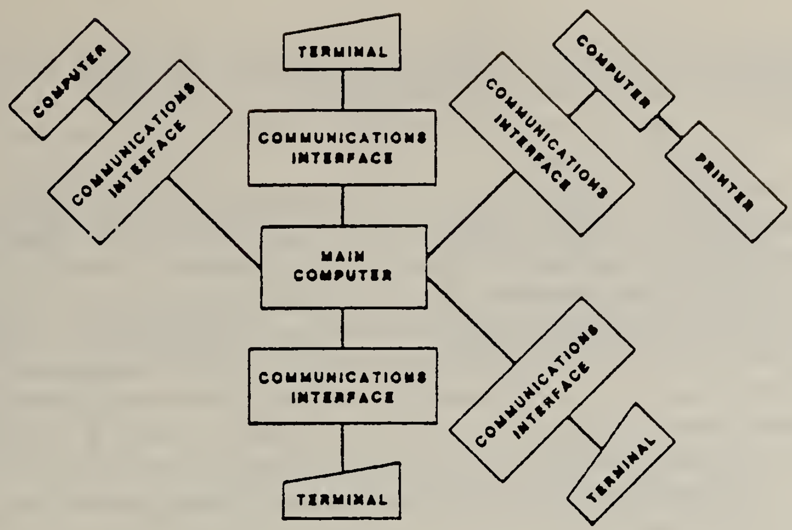


Figure 18. Star network topology

arrangement is that the net is centrally controlled - resulting in a breakdown of the entire system when the hub encounters problems.

2. The Ring. This configuration eliminates the need for a central hub switcher. A signal repeater is located at each node of the network, enabling signals to travel greater distances. The ring permits the use of fiber-optic cable for transmissions, permitting very high

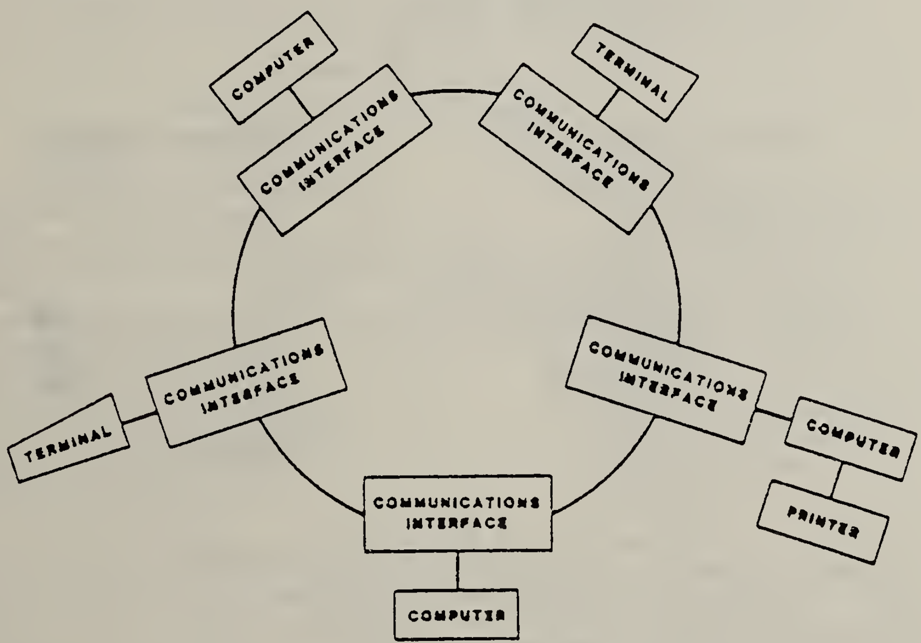


Figure 19. Ring network topology

performance. A major problem with this approach is that if one node goes down, the entire network is out of operation. This also means that when a new station is added to the ring, the network is down.

3. A bus network. This is the most common form of network, and consists of a length of coaxial cable (bus), to which microcomputer stations are attached by means of simple cable taps. There is no centralized control hub, and signals from one station move along the bus in both directions to all stations tapped into the cable. This system is especially suited to a business environment because they are installed relatively easily and cheaply, without requiring the system to shut down when such changes are made. Also, it has a high degree of reliability because there are no active components along the transmission cable. It has the disadvantage of not being able to accommodate fiber-optic cables.

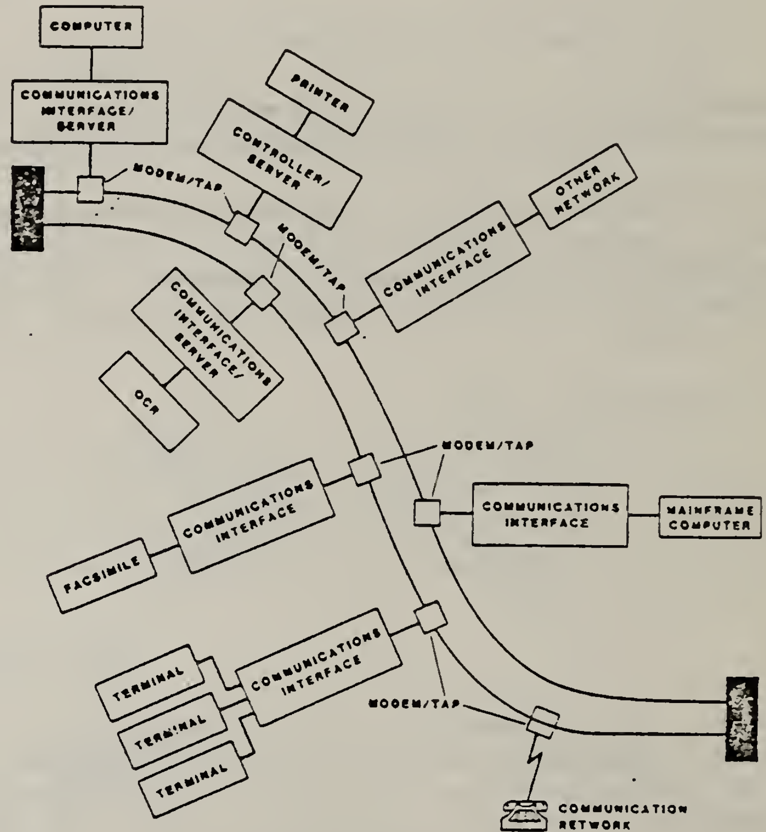


Figure 20. Bus network topology

A current problem with local area network (LAN) is the lack of standardization. To help solve this problem, the Institute of Electrical and Electronic Engineers (IEEE) created project 802 to establish network standards which would in turn impact the standardization of hardware and software components of networks.

Table 26. Evaluation of LAN Network Configurations (Holzman)

1. Star

Positive Features	Negative Features
Permits multiple simultaneous access. Memory may reside in both peripheral terminals (a)-(h) and Central Processor. Ideally suited to continuous monitoring of individual and full system performance. System architecture permits independent hook-up to selected terminals	Central process unit malfunction affects entire system. CPU operational limitations influence system capability. High load operation calls for carefully planned access strategy.

This network scheme emphasizes a top down, centralized decision-making structure; office layout may either reinforce of "soften" this effect.

2. Ring

Positive Features	Negative Features
High overall performance. Each terminal (a)-(h) communicates with every other terminal. Supports distributed decision-making. Repeaters boost signal for large terminal separation distances. Terminal fault detection and diagnosis possible from any other terminal.	Relatively less reliable due to more physical connects. Relatively easy to gain access (security problems). Ring's bandwidth ultimately limits data transmission capability. Requires on-line access control strategy.

The layout of offices using this type of network scheme should supports its positive features and reduce the potential impact of its negative features.

3. Bus

Positive Features	Negative Features
Each terminal (a)-(e) communicates with every other terminal. Control may be decentralized. In wide use today with good track record. Relatively fewer maintenance problems due to use of a common data linking bus. Allows for addition of peripheral equipment with relative ease. Data repeater module(s) may be added along bus for long distance applications. Highly useful for EMS.	Broken bus effectively cripples all down-line communication. Relatively easy to tap (security problems). Bus bandwidth ultimately limits data transmission capability. Requires some strategy (and tailored software) to control user access during "high load" operation.

Office layout with this type of communications network should take into careful consideration the fact of its decentralized system control. All users can speak with the same volume. Office layout may be used to help establish user priorities.

7.3 ETHERNET

Metcalfe and Boggs (127) describes ETHERNET as a system for local communication among computing stations. A typical application is to carry variable length digital data packets among such systems as personal computers, printing facilities, storage devices and larger central computers. The primary objective of the system is to design communications which can grow smoothly to accommodate several buildings containing personal computers and associated equipment. The layout and changing needs of the office led to the choice of a network topology which lends itself to extension and modification with minimal disruption of service.

Lowenthal (121) describes ETHERNET as an example of a LAN. "It envisions a federation of microcomputer device elements communicating with one another through a coaxial cable. No node is in control of the network, and there is no notion of master or slave implicit in the network itself." The system is dominated by "workstations" and by "servers" who directly control the data resources. ETHERNET is an example of distributed data processing (DDP), where the workstation is specifically designed for a given function such as word processing and therefore has a data processing capability such as formatting and editing.

Norris (128) describes the electronic system implemented at Micronet, Inc., an office designed to minimize the paper needed for internal handling. The impetus of the design is to reduce filing space while expediting information retrieval and handling. In planning the facility only off-the-shelf equipment was used. Another design principle is that "the systems and technology are tools, not solutions. People are the solution, and training at all levels is needed to put the tools to work effectively. Most offices have only budgeted for hardware; they have not planned for training, analysis, procedures and integration - with the result that users are often dissatisfied with the effectiveness of the final systems, and place the blame on the technology."

The focal point of the Micronet system is a modular workstation, which includes a VDT terminal to access a central computer, a telephone, and a microfiche reader. In preparing a document, the operator dictates the material by means of a touch-tone telephone connected to a dictagraph system which provides the opportunity to review the dictation. An operator then transcribes the material, using a word processor. After the document has been created and edited it is transported electrically to a microcomputer, where it is indexed and transferred to magnetic tape for future retrieval. The tape is then loaded on a computer-output microfilm (COM) recorder, which converts the electronic data to readable form and records it at 16,000 lines per minute on 4" x 6" microfiche. Formatting for the COM is accomplished by a front-end microcomputer on the COM recorder. The microfiche are then filed in a mass storage and retrieval system which can randomly retrieve the equivalent of more than 20 million pages of material at the push of a button.

An optical character recognition (OCR) unit is used to convert documents in paper form to digital data for revision by a dedicated word processor. Documents outputted by means of the COM, the computer or the word processor can readily be converted into paper form for further processing by the OCR, permitting easy revision of documents without having paper storage. At Micronet, the digital files are checked daily, and if not used in the preceding 90 days, the originator is asked whether they are still needed.

Figure 21 below describes the creation of internally generated information at Micronet.

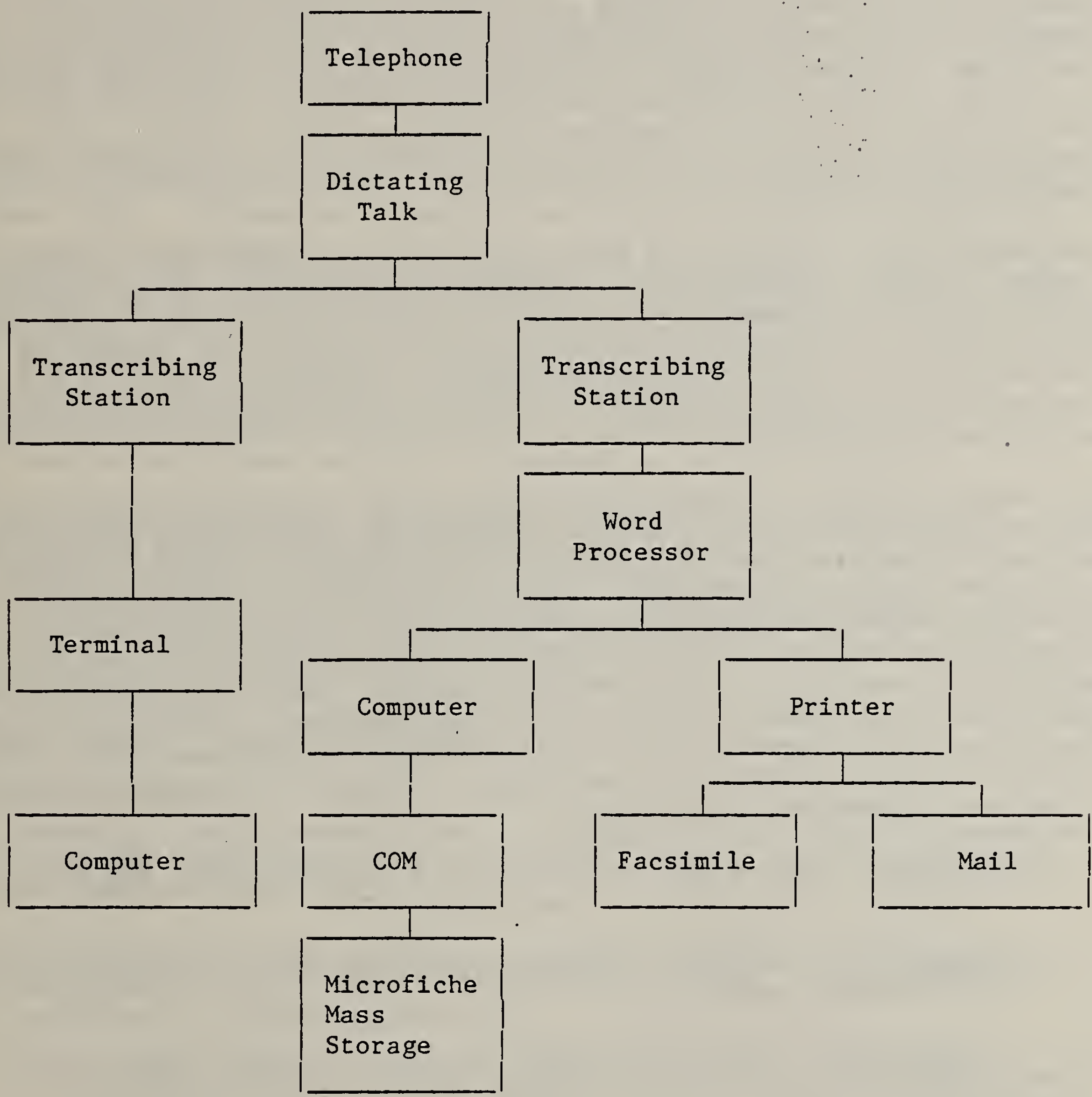


Figure 21. Internally created information Micronet (Norris)

7.4 ELECTRONIC MAIL

While traditional message switching is accomplished by messages being routed to a particular physical terminal, Sirbu (129) observes that electronic mail systems are designed to serve particular users. An important aspect of any mail system is the convenience of using a "third party carrier" between the sender and the intended receiver of mail, so that personal contact between the two people communicating is not required. Another key characteristic of the latter approach is that messages for a given person are stored and can be accessed by him from any terminal connected to the time sharing system. Office automation should provide individuals and offices with communications facilities that permit written messages to be sent at the sender's discretion and delivered in machine readable form to other individuals or groups. The recipient should have the ability to use the messages to suit their own purposes, and be able to treat them with all of the flexibility that they have in handling messages that they themselves create.

Electronic mail is transmitted on private lines or through the telephone systems. Private telephone lines are more expensive and limited to the particular points in the network. They do not permit virtually error-free transmission. Telephone systems are more universally available and charges are based upon actual use, but have the disadvantages of being electronically noisy (resulting in data containing errors), and not being capable of carrying high-volume transmissions.

The communications requirements for electronic mail systems are quite different from those of normal voice traffic. For example, a one letter page can be sent in from 5-10 seconds, but it takes from 11-17 seconds to dial the number required for data transmission. More important, the ordinary telephone lines are characterized by fading, where whole blocks of text may be lost in transmission. One way of dealing with the error problem is the use of packet switching in networks such as TYMNET or Telenet. These value added networks (VAN) lease high capacity channels from primary carriers and then use sophisticated switching computers to break the message into packets, which are transmitted with error detection and correction. Sirbu (S-16) suggests criteria for an ideal communications systems:

° Ubiquity. Access must be comparable to the telephone system, and the terminal hardware must be inexpensive.

° Simplicity. Sending a message should be as simple as typing a letter or dialing a telephone.

° Flexibility. The system should be able to transmit texts of any length, in any format and also be able to transmit pictures.

° Reliability. It must be available for use virtually all of the time.

° Privacy and Authentication. Privacy concerns the protection of messages from inspection by unauthorized persons, while authentication is the positive identification of the sender to the recipient. Most systems use passwords to establish the identity of the user, and attach that identification to any mail sent by the individual.

7.5 TELECONFERENCING

A teleconference is a meeting involving two or more people at two or more different locations, with the discussions being transmitted through audio, digital and/or video techniques. Nilles (130) distinguishes between two types of audio conferences—private and public. In the private conference rooms are instrumented with microphones and speakers. In the private mode, the telephone is used in conjunction with a switching center to interconnect the participants. Audio conferences are useful when the participants know one another and the agenda being discussed is a rather specific and limited one.

In computer conferences, participants use terminals to communicate with one another. It is especially useful for researchers and policymakers, according to Barcomb (131). It enables communications to be rich and interactive and permits real time exchange of information. Another advantage of this mode of conferencing is that asynchronous exchanges of data and other information is possible, whereby people in different time zones can exchange information at a time convenient for each participant. Furthermore, if conference proceedings are to be prepared, all informational exchanges are available in electronic storage, thereby facilitating the preparation of a final report. Both audio and computer conferencing can be augmented by graphics—electronically, or by hard copy material made available beforehand to all participants.

Video teleconferencing offers the greatest potential for substituting for meetings because of the availabiity of powerful technologies to simulate a live meeting. However, although this form of conferencing has received a great deal of publicity, it is not in widespread use as yet because of the costs involved in establishing such systems. The design requirements for a video conference facility are quite stringent.

7.6 DESIGN ISSUES - COMMUNICATIONS SYSTEMS

While teleconferencing is a highly specialized activity, many of the design issues present in the automated office are highlighted in a facility designed for this purpose. Gold (132) cites the following major factors in designing spaces for video teleconferencing:

- The location of the room is an important consideration. For example, when placed in the "executive suite" many potential users will be reluctant to take advantage of it.

- Converting existing conference rooms for teleconferencing often results in acoustical problems. For example, most such rooms are constructed using building materials constructed in 4' x 8' sizes. This generally results in a room with a ratio of length to width to height of 3:2:1, a ratio which reinforces many of the negative acoustic properties of teleconferencing spaces, such as reverberation.

- The equipment often found in teleconferencing rooms (e.g. facsimile devices, input and output systems, video display units) often generate considerable heat and noise, and require special consideration. One solution is to locate much of the electronic support equipment in adjacent rooms, which are acoustically isolated and air conditioned.

- Lighting and color selections for such rooms are of critical importance. Room surfaces should be non-reflecive, and the colors of carpets and furniture should be neutral.

Rosenthal (133) discusses the design requirements for accommodating local area networks. He indicates that the number and placement of buildings (and equipment within buildings) are determined by analyzing the expected functioning entities. Space requirements for networks include:

- Room for interconnection units colocated with support units.

- Available wall and floor space for taps/transceivers.

- Areas within or outside of walls, ceilings and floors for cabling, and repeaters/amplifiers.

- Dedicated rooms or floor space for network control units, placed centrally, or distributed appropriately.

The network should be able to operate under the typical environmental conditions of the buildings in which they are located, with normal exposure to dust, humidity and temperature changes. Specifications for network performance should include the amount of dedicated cooling required for proper operation, and limits for noise and heat generation to ensure that overall environmental quality is not compromised. Finally, the equipment may be required to operate within given electrical constraints, e.g., power, voltage, phase and/or frequency. These conditions are of special importance when the network must be placed into an operational environment.

8. DESIGN CONSIDERATIONS (PRESENT AND FUTURE) FOR AUTOMATED OFFICES

In an effort to obtain preliminary information concerning present design for automated offices, and forecasts about the future, 60 architectural and architectural/engineering firms which specialize in office design were contacted for information by Wilson and Rubin (34); 29 responses were obtained in this inquiry. A followon study was conducted for the same authors by the Institute of Building Designers (IBD), which polled a sample of its membership: 10 responses were obtained. While several specific questions were asked in these inquiries, they were intended to enable the respondents to cover general issues thought to be appropriate for OA design. A brief summary of the findings, and a sample of representative responses are provided below. They included the identification of issues and a description of some of the new design approaches advocated. As might be expected, there was widespread agreement on some points (e.g., the importance of flexibility), but limited consensus on design solutions. (This investigation was a limited one, and its intent was that of a pilot study. The findings should be considered tentative in nature and were not amenable to statistical analysis; they suggest the types of issues currently being considered by designers of automated offices. A comprehensive investigation of OA design issues is needed before general conclusions can be supported scientifically.)

The questions which formed the basis of this study are as follows:

1. What is your design response to change in office methods occasioned by the growing automation of business, institutional, and corporate offices?

2. How do you use and adapt present traditional offices and open-plan office space functions and layouts to the demands of automated office equipment and procedures?

3. What are your predictions concerning future automation for offices?

4. How do you prepare in your present designs for future electronic equipment changes?

5. What recommendations for design criteria and guidelines would you suggest for a major client?

Before summarizing the specific responses obtained to these questions, two general issues will be addressed - the quality of the automated office environment, and the design process used to formulate a program.

8.1 THE ENVIRONMENT BEING DESIGNED

The need to humanize the automated office environment was a subject of discussion by several of the respondents. Musho (a)* provides his impression of the sensitivity of clients for quality environments as follows:

> "Clients are getting more aware of their environment in a general sense and that the advent of more automation has heightened this new awareness even further. It is as if the intensity which the CRT screen imposes on the participant requires an immediate antidote that must be provided by the space immediately around them. By extension, the same is true for the building as well. The working spaces are getting larger for flexibility, and the atrium has been reinvented, to offer changes of scale and the possibility of unexpected social contact."

Gensler (b) supports the same view:

> "It is my opinion that we will not have "high tech" offices as a typical solution, but rather a more traditional, relaxed, and comfortable environment to counterbalance the technology and equipment. As we create a society of knowledge workers with enormous powers of communication, data retrieval, the successful organizations, in order to attract and retain their staff, will be required to provide a humane and quality office environment."

Kurz (c) emphasized the need to be responsive to the requirements of the workforce likely to occupy the automated office. Workers are likely to be well educated, desire stimulation on the job, have a great desire to "see the job through", and participate in decisionmaking. These employees will be sophisticated and discerning about their environments. They will experience more of the overall workplace and therefore will want to have a voice in determining its quality - including issues such as privacy, personalization of workstations, circulation, lighting, and acoustics. They will also be sensitive to their general surrounds - the architecture and the common spaces - indoors and outdoors (e.g., parking lots).

Among the specific recommendations made by several respondents; to improve the quality of the automated office environment are the following:

- ° Specialized areas for the staff, adjacent to CRT workspaces - lounge, recreation
- ° Individually controlled environmental systems - task lighting, HVAC
- ° Modular furniture and systems to situ individual requirements
- ° Spaces set aside for casual conversation - near corridors.

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* Responses are coded in terms of respondents for design firms; survey participants are listed in Bibliography.

Just as the automated office has profound implications for the characteristics of the physical setting, it has altered the procedures typically used by designers - by placing increased emphasis on the need for detailed planning.

8.2 ARCHITECTURAL PROGRAMMING

While architectural programming is an integral part of the building design today, it frequently is accomplished in a rather unsystematic and haphazard manner. The complexity of office automation design is likely to increase the importance of programming activities in the view of Mattison (d):

> "The starting point in determining criteria for any office environment is to first observe the unique qualities or procedures inherent in the client's product, service, or operation which make for its existence and success. A successful critique sorts out the similarities and defines the differences. Each client and situation must be approached as unique. This would, of course, lead to a diversity of solutions dependent upon the relative importance of the findings and objectives of the client and designer."

Waters (e) indicated that his firm has also placed a great deal of importance on the need to thoroughly understand the requirements of their clients.

> "Our design approach is changing. We find we must spend substantially more time developing a thorough understanding of our client's program (i.e., spatial; functional; adjacency; equipment; work, paper, and people flow; mechanical, electrical, and mechanical requirements). This client-architect team approach to extensive programming and planning allows us to give our clients sound advice and realistic designs that balance future needs with today's budget."

8.3 FLEXIBILITY AS A RESPONSE TO CHANGE

The survey respondents were unanimous in their view that the most important design consideration for office automation is the need to account for future changes in their designs. Among the design issues requiring flexibility are the following:

° Power and localized cooling to accomodate heat loads from electrical equipment.

° Mechanical, electrical distribution, lighting, and communications systems.

° Workstation design - to accomodate a range of tasks, and individuals.

° Standardization of components for workstations - work surfaces, task lighting, panels, furniture.

° Changes in space use.

° Air supply and return.

The topic receiving the most attention with respect to flexibility was that of electrical and power supply; the following recommendations were made by respondents:

8.3.1 Wiring and Power Requirements

Deane (e) discussed and evaluates electrical distribution systems as follows:

> "The most important planning consideration and the one which is most difficult and expensive to accommodate is wire management. Equipment types, densities, and locations are all very likely to change frequently within the useful lifetime of a building, so power and communications systems must be designed to move and to adapt. The options for distribution of power, lighting, electronics, and communication services (PLEC) consist of five basic approaches, with greater flexibility generally costly more. The five basic approaches identified are the following:
>
> 1. Raised access floor
> 2. Flat cable distribution
> 3. Integrated floor ducts
> 4. Ceiling distribution and poke-through
> 5. Ceiling distribution and power poles or flex connectors
>
> This office has heretofore used approaches 3 and 4 on most projects. Raised access floor, although seen as a very desirable approach, has generally proven to be too expensive. Until recently, flat cable was not believed to be technically viable, and even now, its primary application will probably be as a supplementary distribution system or for remodeling projects. Ceiling distribution with power poles in open office areas is relatively flexible but has been regarded as aesthetically undesirable. The major problem with approach No. 3 has been the difficulty of planning for adequate flexibility without excessive initial cost. Ceiling distribution with poke-through floor access has the advantage of maximum flexibility with low initial investment; its major disadvantage is the disruption caused by making changes.
>
> The office of the future for clients who can afford to look at life-cycle costs rather than initial costs will probably be served from underfloor plenums created by raised access floors. This approach offers the greatest flexibility, convenience, and planning freedom."

° Spare capacity to main and distribution panels.

° Uninterruptable power supply - battery pack and generator backup.

° Power panels for station-to-station distribution.

- Additional capacity in electrical bus risers.

- Placement of additional sleeves for future power and communications.

- Dedicated circuits for certain equipment - for security purposes.

- Flat wire under the carpet tiles was a favored approached by many respondents for power distribution within an office.

8.4 DESIGN RECOMMENDATIONS AND CONSIDERATIONS (SURVEY RESPONSES)

Following is a summary of some of the general recommendations made by the survey participants. No effort has been made to evaluate these responses. The intent is to describe a range of the alternative approaches being considered by the design community.

Recommendations

Space Considerations:

- Expansion space in the building core for installing additional risers for communications and power.

- Adequate built-in floor/ceiling and/or wall conduits for future wiring.

- An increase in floor-to-ceiling heights - to accomodate the vertical stacking of equipment.

- Less room needed for paper filing - more for workstations.

- Floors with computer facilities an additional 2 feet in height to accomodate wiring.

- Clustering of equipment in specialized areas - facilitate cooling, isolate noise sources.

- Zoning with individual HVAC control - concentrated heat load; accomodate 24 hour occupancy.

Acoustics:

- Floor, ceiling, and wall finishes - material selected for sound properties.

- Even distribution of air-constant sound.

- White noise in open-noise environments.

Lighting:

° Task/ambient systems.

° Individual control at workstation.

Air Quality:

° Humidification to accomodate equipment needs - avoid static electricity.

Energy Efficient Design:

° Designs should be responsive to energy usage.

Specialized Needs:

° Fire protection and security systems for automated equipment.

° Environment system control.

° More local control of environmental systems.

8.5 FUTURE OA EQUIPMENT FORECASTS

° Miniaturization of electronics - will facilitate placement of equipment, lessen problems of cooling and noise.

° Automated equipment will be used at all management levels.

° Advanced telecommunication systems satellite transmission - roofs will have to accomodate antennas.

° Video conferencing will become widespread.

° Centralized computer systems and networks for sharing of peripherals - data, informaton, monitoring or service systems. Any tenant can purchase service; prewired by optical fiber systems.

° More information and computer systems available than can be assimilated.

° Electronic filing systems.

° Grouping of electronic VDT stations.

° Shared use of particular workstation configurations.

8.6 SPECIAL SPACES/ROOMS

° Teleconferencing facilities.

° PBX/Switch Gear Rooms - to interconnect with offices and cover stations.

° Small and Large Conference Rooms.

° Audio-Visual Rooms.

° Storage areas for modular components - workstation, dividers, furniture systems.

8.7 ENVIRONMENTAL AND WORKSPACE CRITERIA

Throughout the report, design information has been presented which pertains to the development of design guidelines and criteria for automated offices. Following, is a compilation of recommendations by professional societies and researchers and suggestions made in Handbooks, which pertains to the design of speces housing office activities. NONE OF THIS MATERIAL PERTAINS SPECIFICALLY TO THE DESIGN OF AUTOMATED OFFICES.

8.7.1 Lighting Recommendations - Illuminating Engineering Society (IES) (135)

Table 27. Illuminance Categoriess and Illuminance Values for Generic Types of Activities in Interiors (IES)

Type of Activity	Illuminance Category	Ranges of Illuminances		Reference Work-Plane
		Lux	Footcandles	
Public spaces with dark surroundings	A	20-30-50	2-3-5	General lighting throughout spaces
Simple orientation for short temporary visits	B	50-75-100	5-7.5-10	
Working space where visual tasks are only occasionally performed	C	100-150-200	10-15-20	
Performance of visual tasks of high contrast or large size	D	200-300-500	20-30-50	Illuminance on task
Performance of visual tasks of medium contrast or small size	E	500-750-1000	50-75-100	
Performance of visual tasks of low contrast or small size	F	1000-1500-2000	100-150-200	
Performance of visual tasks of low contrast and very small size over a prolonged period	G	2000-3000-5000	200-300-500	Illuminance on task, obtained by a combination of general and local (supplementary lighting)
Performance of very prolonged and exacting visual tasks	H	5000-7500-10000	500-750-1000	
Performance of very special visual tasks of extremely low contrast and small size	I	10000-15000-20000	1000-1500-2000	

Shemitz (136) provides a list of criteria for evaluating the quality of task/ambient lighting.

Table 28. Criteria for Evaluating Task/Ambient Lighting (Shemitz)

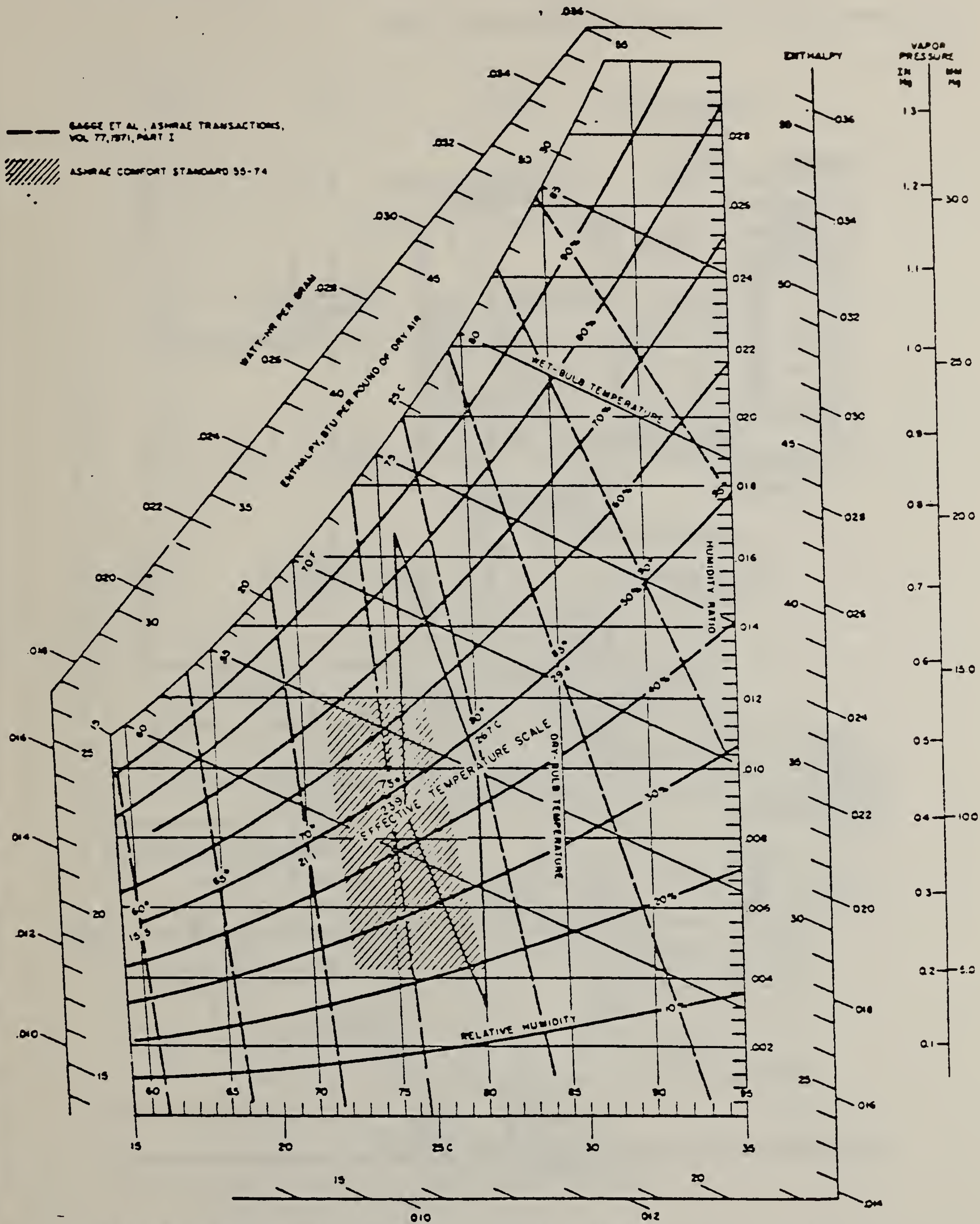
1. Lighting should be evenly distributed over the task area.
2. Veiling reflections should be minimized.
3. A proper brightness relationship between task and surround is essential. (No more than 3:1 in the immediate seeing zone, no more than 10:1 in the total zone.)
4. Luminaires should be glare free. The light source should not be visible.
5. Ballast noise should be minimized by the use of a properly mounted, high quality ballast.
6. The ballast and housing should not radiate excessive heat.
7. Fixtures should be easy to clean and maintain. Replacement of lamps and ballasts should be easy.
8. Fixture should be properly mounted to prevent vibration.
9. Upward light distribution should minimize shadows, while avoiding "hot spots" on the ceiling.
10. Downlights should light the back part of a workstation uniformly.

Table 29. Recommended Illumination and Glare Characteristics for VDTs (74)

Source	Illumination[a]	Glare Control
Canadian DCIEM (Gorrell, 1980)	807-1076 lux	Antireflection treatment required
Groupe de Recherche sur les Ecrans Visualisation (Rey and Meyer, 1977)		
German DIN Standard 66234 (Deutsche Institut für Normungen, 1982)	300-500 lux for positive contrast; $\geq$ 500 lux for negative contrast combination filters	Diffusing surface, micromesh filters, optical coatings, sprays, hoods,
German Safety Standards (Zentralstelle für Unfallverhutung und Arbeitsmedizin, 1980)		Avoid disturbing reflections
Snyder and Maddox (1978)	$\leq$ 75 lux	Antireflection treatment as needed to obtain contrast required
Swedish National Board of Occupational Safety and Health (1979)	200-300 lux; supplement was required	Avoid bright reflections
Technical University of Berlin (Cakir et al. 1978)	500 lux	Avoid focusable reflections; diffusing surface
University of London (Reading, 1978)	500-750 lux	
MIL STD 1472B (U.S. Department of Defense, 1974)[b]	$\geq$ 540 lux; 1075 lux preferred; consistent with other tasks	Avoid reflections that reduce information transfer
Video Display Terminals (Cakir et al. 1980)	300-500 lux	Optical coating, diffusing surface, polarization filter, micromesch filter

[a] 10.76 lux = 1 ft-candle.
[b] See MIL STD 1472C (U.S. Department of Defense, 1981) for additional information.

8.7.2 Thermal Comfort Recommendations - American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) (137)



* The envelope applies for lightly clothed, sedentary individuals in spaces with low air movement, where the MRT equals air temperature.

Figure 22. New effective temperature scale (ET*) (ASHRAE)

8.7.3 Ergonomic Criteria for Workspaces (138)

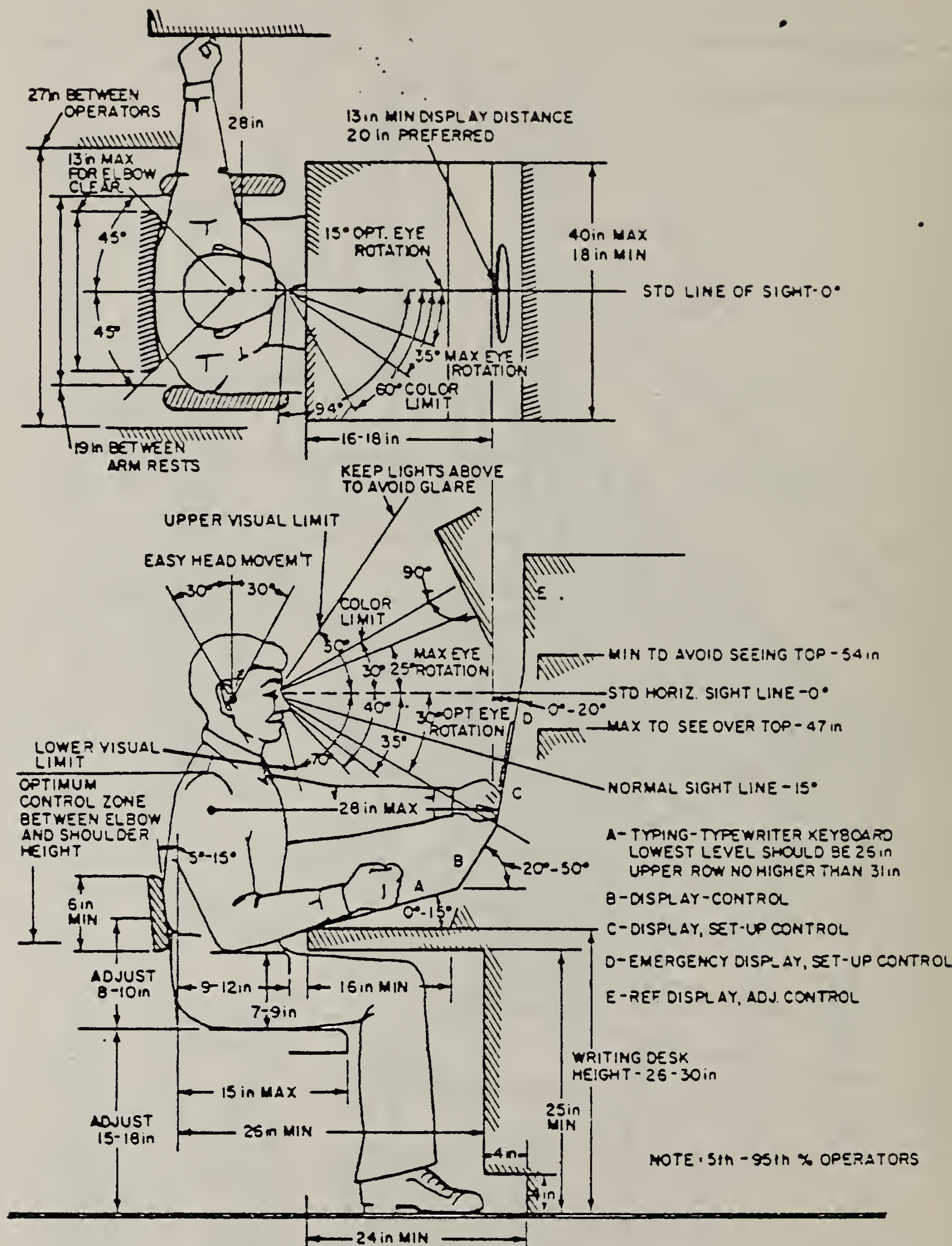


Figure 23. Suggested parameters for mockup of a seated operator console

Table 30. Recommended Workstation Dimensions for VDTs (mm) (74)

Source	Work Surface Height	Work Surface Width	Work Surface Depth	Knee Room Height	Knee Room Width	Knee Room Depth
Canadian CIEM (Gorrell, 1980)						
Groupe de Recherche sur les Ecrans Visuelisation (Rey and Meyer, 1977)						
German DIN Standard 66234 (Deutsche Institute fur Normung e.v, 1982)	650-750; ≤ 720 if fixed	> 1200	900	≥ 660; 690 preferred	≥ 1200	
German Safety Standards (Zenthralstelle dur Unfallverhutung und Arbeitsmedizin, 1980)	680-760; 720 if fixed	≥ 1200; 1600 preferred	50-100 in front of keys	≥ 650; 690 preferred	580	600
Snyder and Maddox (1978)						
Swedish National Board of Occupational Safety and Health (1979)						
Technical University of Berlin (Cakir et al. 1978)	650-750; 720 if fixed		690	690		
University of London (Reading, 1978)						
MIL STD 1472B (U.S. Department of Defense, 1974)[a]	740-790	≥ 760	≥ 640	≥ 640	≥ 510	≥ 460
Video Display Terminals (Cakir et al. 1980)	≤ 720				800	700

[a] See MIL STD 1472C (U.S. Department of Defense, 1981) for additional information.

8.7.4 Acoustical Criteria

Table 31. Types of Offices Applicable to Articulation Index Ranges (Walker (43))

I	00.00- 0.05	Confidential Privacy. Speech cannot be followed with understanding.	a) Closed offices with STC of 40-45. b) Open plan, or office landscape environment.
II	0.05- 0.20	Normal Privacy. Speech may be understood with careful listening attention but should not interfere with the ability to concreate on other work.	a) Closed offices with STC of 35-40. b) Open-plan environmental.

Approximate Requirement for Class II (E-9)

1) Acoustical ceiling, selected for AI potential.
2) Carpet.
3) Acoustical screens; selected for AI potential.
4) Masking Sound. (This should be provided by electronic masking system unless there is sufficient other background noise, such as from heating and ventilation systems. Electronic masking sound is preferred, and definitely would be needed in the lower end of this class.)

5) Acoustical wall panels (probably needed at the low end of this class (0.5)); possibly not needed at the higher end (0.20) if electronic masking noise is used.
6) Position and type of luminaries not quite as critical as in the confidential privacy range.

III	0.20- 0.35	Marginal Privacy. Provides a relatively quite office environment when privacy is not of supreme importance.	Open-plan environment
IV	0.35- 0.50	Fair communciation, no privacy typical, relatively noisy environment. Does not promote maximum productivity.	
V	0.50-	Good to excellent communication, no privacy.	Not normally an office feature. Usually found only in conference rooms and auditoriums.

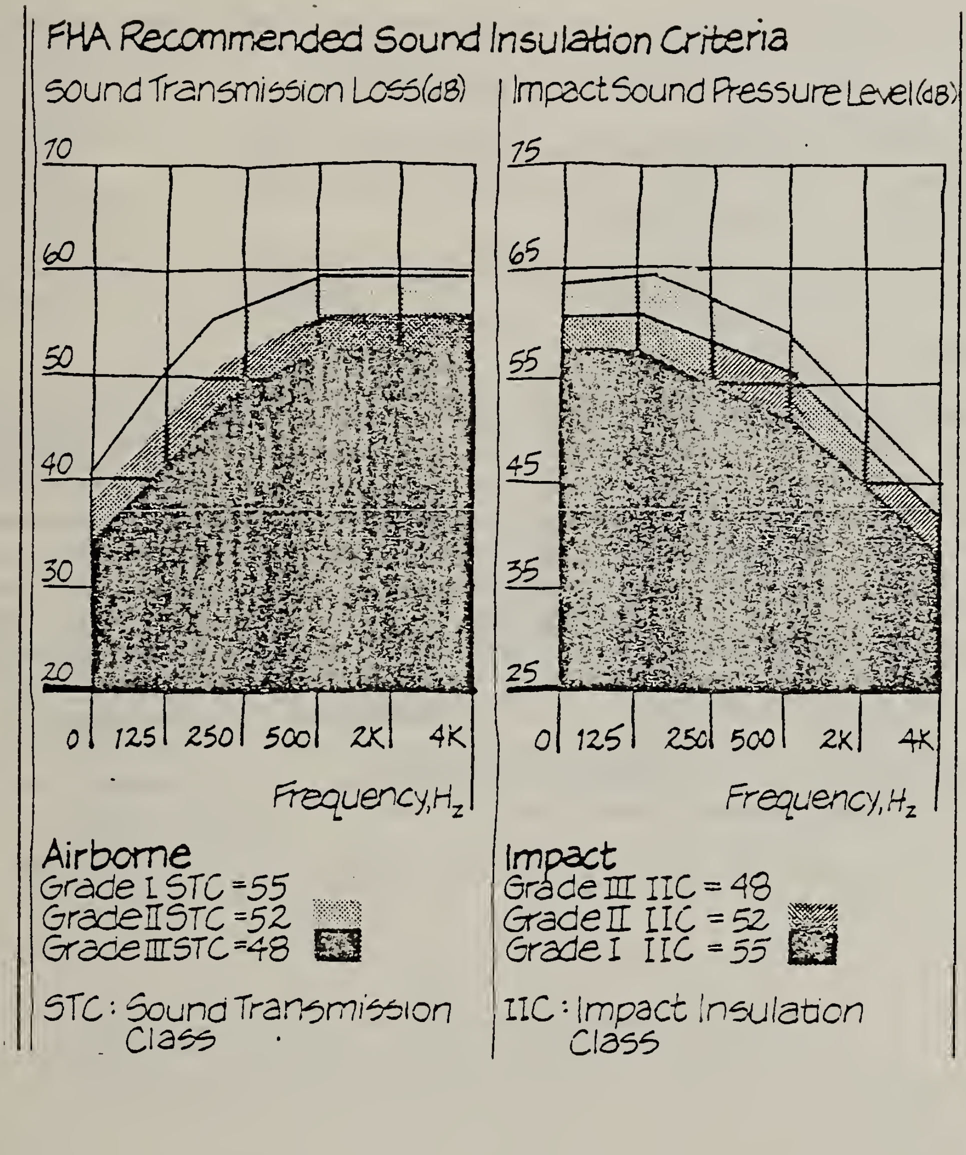


Figure 24. FHA recommended sound insulation criteria (139)

Table 32. Noise Criteria (NC) Recommended for Rooms (Beranek (46))

Type of room	Maximum permissible level (dB) (measured in vacant rooms) NC
Secretarial offices, typing	50-55
Coliseum for sports only (amplification)	50
Small private office	30-35
Conference room for 20	30
Movie theater	30
Conference room for 50	20-30
Theaters for drama, 500 seats (no amplification)	20-25
Homes, sleeping areas	20-25
Assembly halls (no amplification)	
Schoolrooms	25
Concert halls (no amplification)	15-20

8.7.5 Indoor Air Quality

Energy conserving design - buildings with unopenable windows, increased insulation, "tighter" construction, and reduced ventilation - has resulted in a concern for the air quality in buidlings, according to Messite (140). She suggests that the reduced outdoor air supply has increased the potential for the accumulation of noxious agents in office air. Office workers in such buildings have complained about such factors as undesirable odors and irritation of the skin and eyes. In addition to design concerns, air quality issues are thought to be influenced by the new materials used in building construction and rehabilitation and chemicals used in office systems - e.g., duplicating machines. Spengler and Sexton (141) indicated tht the discomfort of office occupants may be the result of a synergistic effect of a combination of environmental contaminants and environmental conditions. They suggest control measures for indoor air pollutants (table 33).

Table 33. Control Measures for Indoor Air Pollutants; Responsibilities (Spengler and Sexton)

Control Measure Description	Pollutant	Example
Ventilation: dilution of indoor air with fresh outdoor air or recirculated filtered air, using mechanical or natural methods to promote localized, zonal, or general ventilation	Radon and radon progeny; combustion by-products; tobacco smoke; biological agents (particles)	Local exhaust of gas stove emissions; air-to-air heat exchangers; building ventilation codes
Source removal or substitution: removal of indoor emission sources of substitution of less hazardous materials or products	Organic substances; asbestiform minerals; tobacco smoke	Restrictions on smoking in public places; removal of asbestos
Some modification: reduction of emission rates through changes in design or processes; containment of emissions by barriers or sealants	Radon and radon progeny; organic substances; asbestiform minerals; combustion by-products	Plastic barriers to reduce radon levels; containment of asbestos; design of buildings without basements to avoid radon; catalytic oxidation of CO to CO_2 in kerosene burners
Air cleaning: purification of indoor air by gas adsorbers, air filters, and electrostatic precipitators	Particulate matter; combustion by-products; biological agents (particles)	Residential air cleaners to control tobacco smoke or wood smoke; ultraviolet irradiation to decontaminate ventilation air; formaldehyde sorbant filters
Behavioral adjustments: reduction in human exposure through modification of behavior patterns; facilitated by consumer education, product labeling, building design, warning devices, and legal liability	Organic substances; combustion by-products; tobacco smoke	Smoke-free zones; architectural design of interior space; certification of formaldehyde concentrations for home products

Responsibilities for Healthful Indoor Environments

Individuals

Maintain and properly use products and appliances
Exercise direct discretionary control of ventilation in most residential and some occupational circumstances

Building Owners or Managers

Operate and maintain a balanced ventilation system in compliance with building ventilation codes
Use zone ventilation or local exhaust for indoor contaminant sources
Properly use cleaning solvents, paints, varnishes, herbicides, insecticides, furnishings, and insulation

Architects, Developers, Contractors

Adopt protection of indoor air quality as a design objective
Design ventilation systems to comply with new ASHRAE standard 62-1981
Provide for separation of occupants and indoor pollutant sources
Elimination or containment of potential sources

9. PROSPECTS FOR THE AUTOMATED OFFICE - A PRODUCTIVE WORKPLACE?

While technology has provided the major impetus for office automation today, as this study has demonstrated, many experts on this topic are wary of current practices and observable trends. Their concern centers on the narrowly defined uses of automation now prevalent, which often places many workers in the position of being adjuncts to the machines that they operate. This viewpoint is said to be shortsighted from the standpoint of meeting organizational requirements and the personal needs and desires of the office workforce. Many of the problems associated with office automation are traceable to this orientation.

The United States is rapidly evolving into an information-based economy. A recent study by the American Productivity Center (143) was concerned with this trend. This study indicates that almost 53 percent of the adult workforce in this country is engaged in white collar work, accounting for 70 percent of the total annual payroll of all industry. The same report notes that the Bureau of Labor Statistics estimates that the white collar workforce will grow to 65 percent by 1985.

Since so many activities are now concentrated in the office, the productivity of office workers has received considerable attention by organizational researchers and corporate managers. A study by Harris (32) indicates that productivity in the office has been virtually stagnant for almost a decade; increases averaging .02 percent per year from 1973 to 1981. (This time period coincides with the rapid expansion of the white collar workforce.) The trend of office-based activities, the productivity findings, technological advances accompanied by decreased costs of office machines, systems, communications, and computers, have all combined to create a great demand for the automation of office functions. Yet, at a time when technology is seen by some observers to <u>the</u> solution to office productivity problems, others are skeptical about this view; they point to the importance of design, organizational and human resource issues as key factors which influence productivity (4, 7, 17, 23).

9.1 DESIGN ISSUES

All too often office automation has resulted from the piecemeal acquisition of new devices and systems which have been placed on available desks and other work surfaces in an environment designed to accommodate information in paper form. Systematic design planning has been a rarity. This process has resulted in a considerable number of complaints by workers about the unsuitability of their offices for performing VDT-based activities. Noise and glare produced by inappropriate lighting systems lead the list of concerns, with the design of workstations also receiving considerable attention. Researchers and designers indicate the need for a thorough architectural programming activity to precede the implementation of office automation systems (7, 28, 77). This planning should be accomplished with the designer working closely with the organizational client, including the end-user, to identify and respond to their unique requirements.

The most frequently expressed requirement for the automated office is for flexibility, to accommodate future organizational and technological change. Among the systems singled out for particular attention are:

- Power and localized cooling to accommodate heat loads from electrical equipment.
- Mechanical, electrical distribution, lighting, and communications systems.
- Workstation design - to accommodate a range of tasks, and individuals.
- Standardization of components for workstations - work surfaces, task lighting, panels, furniture.
- Changes in space use.
- Air supply and return.

Another major challenge for the designer to achieve a high-quality work setting to offset the technology dominated office. Burlage (g) notes that:

> "There is a distinct need for personal communication among office and technical people, occasional by the long hours of intense work on the CRT. Buildings should have spaces for the casual interchange of ideas on a formal or informal basis by using conference rooms, coffee areas, casual lounges in corridors, and a variety of cafeteria, vending and dining spaces."

Developments in computerized control systems have made it possible to automate many building systems such as HVAC, lighting, energy management, fire, and security. However, the problems associated with the early word processing experiences should be considered before fully automating systems simply because the technology exists to do so. Individuals and working groups often have requirements that differ from one another, and standardization of environmental conditions isn't always the most effective solution. Furthermore, automation is frequently considered from an "all-or-none" standpoint; a mixed system (partially automated) merits consideration as a means of providing a balance between manual and automated control. Even when systems are fully automated, a manual override function is often needed to accommodate individual needs. The design of such systems requires an optimization of several factors: economic, operational, and user requirements and/or desires.

While open-office design is being used by more and more organizations, research evidence suggests that the automated office may be better accommodated by a variety of open-spaces and private offices. Questionnaire surveys have uncovered a number of complaints associated with open-space design; the lack of visual and auditory privacy and disturbance by noise and unwanted intrusions were prominently mentioned as problem areas.

Technological developments have raised new and complex demands on the architect. Systems are now available to monitor and control building service, maintenance, and many operational functions. The effective integration of these systems is a major design requirement. Teleconferencing is being used in some organizations as a substitute for face-to-face meetings. The design of appropriate facilities for this purpose requires stringent control of heating, lighting and acoustical systems. Finally, although office automation is proceeding at a rapid pace, for the forseeable future paper will continue to be an important informational medium. This factor has particular significance for two aspects of design, space requirements and lighting. Space planning will be complicated by the need for accommodating new electronically based information storage systems and microfiche records, in addition to the paper-based systems still required. With respect to lighting, many employees at VDT-based workstations are required to alternatively read material appearing on: (1) a VDT screen, (2) paper, and (3) a microfiche viewer. The design of lighting systems which accommodate all of these tasks poses many difficulties for the lighting profession.

9.2 HUMAN RESOURCE (ERGONOMIC) ISSUES

It is self-evident that the greatest single determinant of office productivity is the performance of the working staff. Yet, discussions of this topic are frequently confined to technological "quick-fixes." Management and office automation experts are in general agreement that ergonomic and technological factors must be considered jointly, if office productivity is to improve in the future (5, 11, 12, 17). Technology should be integrated into the workplace in a way that increases work effectiveness, while not compromising the quality of working life. The experiences of many organizations which introduced word processing into their offices and encountered unexpected problems, support this recommendation (18, 31).

The advent of word processing in some organizations resulted in a variety of complaints. The typist often had little or no contact with the author of the copy being worked on, and limited opportunity to carry many jobs through from beginning to end. A major concern expressed was the feeling that "the word-processor was in charge;" their work was being subordinated to the requirements of technology and pre-programmed work methods, leaving little room for personal initiative. In short, the job was becoming depersonalized and no longer under the control of the individual worker. These feelings were frequently mainfested by lowered morale and impaired work performance (7, 9, 20). Finally, considerable evidence exists to suggest that in many instances where office automation has resulted in outright failure (reduced efficiency and/or productivity), the primary reason for this outcome has been the lack of its acceptance by the workforce (61, 66, 80).

Much of the reported experiences with office automation deals with the experiences of clerical and administrative personnel, and for the most part predates the automation of managerial and professional jobs. With the advent of more such knowledge workers in the automated office, the general makeup of the workforce is changing. Current office workers are more highly educated than their earlier counterparts and indicate the desire for better work surrounds, and greater involvement in making decisions which affect their jobs.

Recent findings have demonstrated the importance of these issues in automated offices. For example, Bickson and Gutek (142) conducted a questionnaire survey in 55 offices of large and small organizations with office automation experience. Their purpose was to determine the satisfaction of the office workers with the automation of their jobs. The workers surveyed were primarily from the professional and managerial staffs, and were highly educated; 84 percent of the respondents had some college training. Four issues were identified as determining user satisfaction with their automated office systems.

1. Functionality: what the system requires to enter, organize and store information.

2. Equipment performance: the speed and quantity of maintenance required, VDT and printout characteristics.

3. Interaction: whether the user is equipped to interact effectively with the computer.

4. Environment: adequacy, convenience, and comfort of equipment, funiture and space.

The authors found that the respondents where generally pleased with the functionality of the equipment but that they were dissatisfied with the work environment, which was generally considered to be uncomfortable and inappropriate for the work to be performed. Complaints about the environment take on great significance when we consider that the investigators found the office environment to be an important predictor of satisfaction with the office technology. The survey respondents were significantly more positive about the effect of computers on their work (quality and quantity), than on the potential effects on the "quality of working life." Finally, variety of work, and the approach of the organization in introducing change, were important contributors to satisfaction; individual control and participation being positive factors.

In another study, the American Productivity Center (143) dealt with the same issues that concerned Bickson and Gutek (142), and their findings were quite similar. A questionnaire survey of 140 firms was conducted, to examine the relationship among human resources development, automation technologies, and environmental considerations. This investigation, like the previous one, was concentrated on professional and management tasks, rather than the routine clerical and administrative functions which were the focus of early office automation activities. The goal for automating the operations of professionals and managers is said to be improved quality (added value) to work, not increased "efficiency", which is equated with more output and/or reduced costs.

The authors conclude that increased productivity in office activities results from the effective integration of people, tools and places. This integration is to be accomplished by proper planning by a team comprised of organizational representatives from human resources, technology and information processing, and design - who often find themselves in competition with one another in productivity improvement programs.

The ultimate users should control the development of information systems, their purchase and maintenance according to Strassman (17). This approach leads to job enrichment as a means of improving performance insteand of depending on technology. The goal should be to develop generalists rather than technical specialists, according to Strassman. People should be encouraged to deal with situations of increasing complexity rather than be severely limited in their freedom to operate as creative employees.

9.3 ORGANIZATIONAL AND INFORMATIONAL ISSUES

Organizations are required to cope with a fast-changing environment in order to survive and prosper. Technological advances, the "information explosion," and the growth of the white-collar workforce has led to an increasing reliance on office automation to improve the productivity of office worker. However, as Hammer (90) and other office automation experts point out, automation is a potential means-to-the-end of improved organizational effectiveness, not the solution to productivity problems. They also observe that at present, technological capabilities rather than organizational requirements still provide the major impetus for automation, and that this emphasis is considered to be misplaced.

The first office activities to be automated were selected largely because they could be readily analyzed, simplified and standardized. A variety of office functions were thereby restructured to be suitable for the new technologies available in the marketplace. The standardization of routine tasks fostered the development of computer-based procedures which resulted in clerical and administrative activities that were largely pre-planned and pre-structured by people other than the users. Considerable evidence exists that this "model" for office automation is not an appropriate one for the activities of professionals and managers, where the greatest potential for improved productivity is anticipated (9).

Knowledge workers must cope with problems of ever-increasing complexity and a proliferation of information which must be somehow assimilated and acted upon. Moreover, they are required to perform creative and planning functions, often with the limited and uncertain data, highly individualized kowledge and experience, in a rather unstructured information environment (84). Activities such as these are not readily amenable to analytic and standardized treatment.

Moreover, the nature of traditional managerial and professional work is characterized by the individual being given a particular set of job responsibilities, and considerable freedom to formulate appropriate procedures for carrying them out. The degree of autonomy associated with this work is considered to be one of its major attractions, and plays a major part in the satisfaction derived in pursuing these careers (58). To the extent that knowledge workers are required to adopt to work methods and technologies selected by others, they are likely to be less productive, and less satisfied with the quality of their working life (58). In order to function at maximum effectiveness therefore, the knowledge worker requires tools that are flexible and powerful and under his control, and an environment which supports mentally demanding work. Automation has an important role in supporting these activities, but a far different one that it has played in the past.

Knowledge workers require automated systems that are responsive to them; requiring little training or expertise to operate. The systems should provide the capability to develop and maintain information designed for particular purposes, e.g., Decision Support Systems. The microcomputer-based workstation of today has data storage and processing capabilities which enable many managerial and professional activities to be performed without external support - personal or informational. At the same time, the complexity (and interdependency) of many of their problems requires the capability to readily communicate with colleagues (and data bases) in their own organization, and with the "outside world." Whether working independently or interactively, a great deal of autonomy is exercised by the individual in selecting and organizing the resources needed to accomplish the job at hand.

As the knowledge workers become the most important users of office automation, it is likely that they will want more control over their jobs and their environments, which can provide a respite from their immersion into technology. Studies of worker satisfaction by Harris (31) and Marans (40) support the conclusions cited above, about the importance of this attribute of office work.

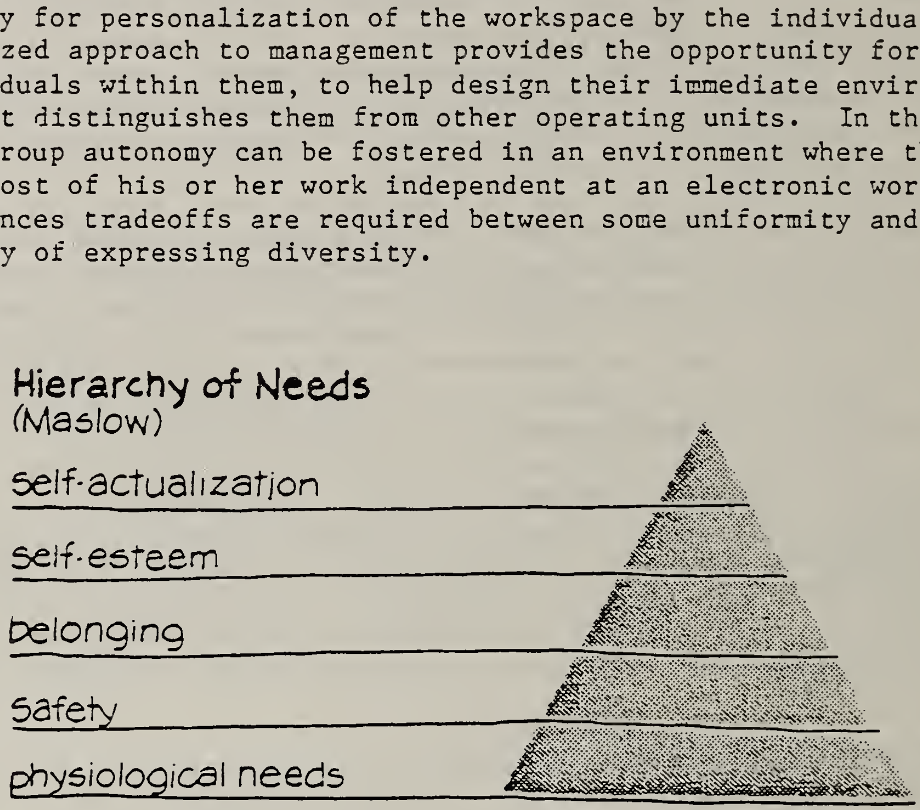
Individual control can take many forms:

- Environment - lighting, heating
- Information
- Work Procedures
- Task Decisions
- Workspace
- Communications
- Social Settings
- Furniture - selection, modification
- Personalization of Space
- Planning of Individual Work

Ackoff (77) discusses the relationship of the working staff and an organization. He notes that an organization is a purposeful system and that the people within this system, comprise an important system component, with purposes of their own. He observes that "how well an organization performs depends on how it is affected by both the people who are part of it and the systems of which it is a part."

The continuing health of an organization, according to Ackoff, is dependent on its ability to respond creatively to change by proper planning, which should maximize the most important organizational resource--its staff. Planning should therefore be accomplished by having workers participate in the decision making process as it affects the workplace to the extent possible. The process includes environmental and ergonomic issues, as well as those of "job design". This approach not only responds to the needs of the individual for personal growth and development (see figure below), but increases the "stake' in the outcome. It also provides essential detailed information about particular job functions unavailable elsewhere.

Management style is an important determinant of the overall layout and appearance of the standard office and the electronic one. One important decision to be made concerns the balance between design uniformity and diversity within the organization, among working groups, the hierarchy within the organization and for individuals. A centralized organizational management style frequently results in considerable uniformity throughout the office, with little opportunity for personalization of the workspace by the individual. The decentralized approach to management provides the opportunity for working units and individuals within them, to help design their immediate environments in a manner that distinguishes them from other operating units. In this way, the sense of group autonomy can be fostered in an environment where the individual performs most of his or her work independent at an electronic workstation. In many instances tradeoffs are required between some uniformity and the possibility of expressing diversity.



Hierarchy of needs (Maslow)

9.4 SOME TECHNOLOGICAL ISSUES

A combination of technical and economic factors are cited by Magleby (144) as major forces which will accelerate the trend toward office automation. Economic developments include the high cost of energy and travel, the increased cost and population of knowledge workers, and the increased cost of office operations. Some of the technical developments are the availability of advanced PBX's using digital technology that can be integrated with computers into complete office systems, advances in computer hardware and software, and reduced cost of these systems by advances in the semiconductor industry; in recent years the average price decline in minicomputers has been more the 30 percent per year.

The author indicates that computer systems and communications systems are converging in two ways: (1) users increasingly require office information systems and communications systems which are combined into providing a single service, (2) communications systems are increasingly based on computer technology. Future office systems will require many layers of communication linkages, unlike those today which tend to be centrally organized.

Technological advances which affect office design and operations are occurring at an ever-increasing rate. These new technologies range from improved and new devices to perform specific office functions, to integrated systems with the capability to automate many of the operational and service systems of buildings. One of the most significant developments is the central importance given to the individual workstation. Many microcomputer-based workstations have the information processing, and other capabilities, equivalent to that possessed by large organizations in the recent past. Furthermore, by means of local area networking these capabilities can be significantly expanded. For example, information can be exchanged with colleagues in electronic form to facilitate cooperative efforts such as report writing.

The central role played by paper as an informational medium in the office is being supplanted by both electronic and microfiche systems. This change has greatly increased the capabilities to store information, while at the same time has reduced the space requirements for such purposes. The fact that information is now available in so many forms has posed the technological challenge of effectively integrating these media for a comman purpose, e.g., preparing a document.

Technology has provided the opportunity to perform traditional office functions in new ways. For example, electronic mail is becoming increasingly popular as a means to facilitate internal and external communication. It is also becoming commonplace for employees away from the office (on travel or at home) to be able to access information in the office by means of a microcomputer or a remote terminal. Finally, teleconferencing is gaining acceptance in many organizations, as a substitute for face-to-face meetings.

Several technological components of the automated office of the future are identified by Tapscott and MacFarlane (145).

- Information gathering and capture. At present, word processing is the only "sophisticated" text entry system in most offices. A debate is under way, concerning the relative merits of providing special hardware with limited functions as a means of inputing data to accommodate non-typists, or whether standard typing keyboards are appropriate for this purpose.

- Information storage. New developments include bubble memories and optical disks.

- Information retrieval. Natural language is needed, as is the requirement to focus on the management decision process. The design of the human interface is important; systems which can respond to how people actually think and compose copy.

- Information integration. Digital networks providing voice, image, and textural information to office and home over fibre-optice links already exists, and points to the way toward more complex integration of information and communication.

Martin (146) forsees that the answer to high-speed interoffice communications might be the communication satellite systems now being developed and used. These systems use all-digital transmission, permitting the integration of voice, data and image data. The advantages of such systems is that cost is not linked to distance, and that any number of stations can be linked simultaneously.

9.5 OFFICE AUTOMATION PROBLEMS: GENERAL AND SPECIFIC

Technological advancements in office systems have been too rapid for them to be properly assimilated by most organizations according to Magleby (144). He observes that this results in an increasing gap between what is technically feasible and the organizational practices in being. In Sadleir's (147) view, "the problem is one of complexity arising from the convergence of technologies focused on a 'new' area - the office. We are facing this target without much knowledge of what today's office is, and with only marginal success at utilizing the technologies that we have already, despite at least two decades of effort."

Tapscott and MacFarlane (145) indicate that as organizations have grown and and increased in complexity, the need to decrease the amount of data, and increase the amount of usable information available to the knowledge worker, has never been greater. They believe the primary problem with office automation to be the lack of appropriate methodologies to assess the automation needs of an organization; the design and implementation of such systems, and finally assessing the effects of such changes.

These, and other experts have identified specific problems associated with office automation; a sample of them are mentioned below:

- Office design is not given appropriate attention.
- Office automation is often implemented with insufficient and inadequate planning.
- The functions performed in offices are not well understood.
- Improved methods of measuring office productivity are needed.
- Organizational and ergonomic issues are not sufficiently considered.
- There is an absence of industry-wide standards for signals, codes, protocols and hardware interfaces; compatibility problems abound.
- No agreed-upon criteria exists to distribute information effectively.

- There is insufficient integration of functions at workstations.

- More forums are needed for interested parties (e.g., users, researchers, vendors and designers) to exchange information.

Markus (148) is concerned with determining the effectiveness of automation systems after they have been implemented. He observes that evaluations of computer systems usually focus on determining what happens when a system is turned over to the user. Measures include: success or failure of a system, rates of use, and the satisfaction of the user. In almost all instances, the dependent variable is called "success of the system" despite the fact that the outcome is evaluated before the user has had an adequate opportunity to use the system. The author suggests that the implementation of such systems is analagous to building design, where it may take from six to 24 months to "shake down" the building sufficiently; that is, to enable the various subsystems to be "fine tuned".

Another shortcoming in many evaluations according to Markus is that the organizational consequences of introducing computer systems are not sufficiently examined. For example, system designers often obtain feedback information about the adequacy of the system exclusively from the client, the individual or organizational unit who purchased the system. The end-user of the system is often neglected in such an evaluation.

9.6 LOOKING AHEAD

In a summary of a "new perspective on the office of the future", Tapscott and MacFarlane (145) the authors identify several critical needs.

- User requirements for communications should drive office automation, not technology.

- A multidisciplinary perspective is needed to address the problems, incorporating information science, management sciences, behavioral research and interior design.

- Ergonomic issues are important in system design and implementation, e.g., user participation and involvement is needed throughout the process.

- Education and training of users is also an essential ingredient of an automation program.

- Studies should not be strictly empirical; scientific methods must be used, including the development of analytic procedures to obtain reliable and pertinent measures of activities, functions, processes and attitudes in office settings.

The design approach to the automated office today is directed toward meeting the needs of the average office worker performing typical tasks in a characteristic organization. This depiction of the automated office is both widespread and meaningless! There is no such thing as a typical:

- Person
- Organization
- Task
- Office
- Office Automation System
- Workstation
- Office Procedure(s)

Organizations and individuals have unique characteristics which merit attention in design, and it is the function of the design process to develop the information required to respond to the particular of requirements of both of them. Many of the writers cited earlier have identified the need for a high quality environment to offset the increasing presence of technology in the office. Design responses to this need should not be considered as extraneous to the objectives of an organization, but integral to the well-being of the staff and therefore a pragmatic investment to support its most important (and most expensive) resource.

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10.1 RESPONSES TO DESIGN INQUIRY

The following organizations responded to the inquiry for information by Wilson and Rubin (134) concerning their design approaches to present and future office automation:

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a. I.M. Pei & Partners, New York, N.Y.
b. Gensler and Associates, San Francisco, Cal.
c. 3D International, Houston, Texas
d. The Grad Partnership, Newark, N.J.
e. Morris Aubrey Architects, Houston, Texas
f. Heery & Heery, Atlanta, Georgia
g. The Architects Collaborative, Cambridge, Mass.

Not Cited in Study

Architectural and Architectural/Engineering Firms

° Albert Martin & Associates, Los Angeles, California
° Charles Pankow Inc., Altadena, California
° The Eggers Group, New York, N.Y.
° Fishbach Corp., New York, N.Y.
° George Hyman Construction Corp., Bethesda, Md.
° Gresham Smith Partners, Nashville, Tenn.
° The Gruzen Partnership, New York, N.Y.
° Haines Lundberg Wahler, New York, N.Y.
° Harry Weese & Associates, Chicago, Ill.
° HOK, St. Louis, Mo.
° Jack Train and Associates, Chicago, Ill.
° John Portman and Associates, Atlanta, Georgia
° The Kling Partnership, Philadelphia, Pa.
° Leo Daly, Omaha, Nebraska

° The Luckman Partnership, Los Angeles, California
° Marnell Corrao Associatse, Las Vegas, Nevada
° Murphy/Jahn, Chicago, Ill.
° Opus Corporation, Minneapolis, Minn.
° Perkins and Will, Chicago, Ill.
° Skidmore, Owings & Merrill, Chicago, Ill.
° Smith Hinchman Grylls, Detroit, Mich.
° Turner Construction Co., New York, N.Y.

Interior Design Organizations

° Institute of Business Designers

  ° National Office, Chicago, Illinois
  ° Carolinas Chapter, Charlotte, N.C.
  ° Northern California Chapter, San Francisco, Cal.

° Associated Interior Design, Columbia, S.C.
° Business Design Group, Boston, Mass.
° Design Concepts, Grimes, Iowa
° Interiors Partnership, Grand Rapids, Mich.
° Interiors Unlimited Inc., St. Louis, Mo.
° Royal Equipment Company, Kansas City, Mo.
° Southwest Business Interiors, San Diego, Cal.

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11. APPENDIX - INFORMATION DEVELOPMENT METHODS

If the researchers and other office automation experts cited in this report are correct, the conclusion is inescapable that detailed planning and information development prior to making office automation decisions is critical, if automation is to fully achieve organizational goals. Many of the researchers cited in this report have developed methods of acquiring OA information, as have others, not yet mentioned in the text. This appendix contains a variety of such methods, dealing with a range of issues. It is designed to provide the reader with an overview of some approaches available to meet particular information needs.

11.1 DESIGN INFORMATION

Veneklasen (149) developed a checklist for evaluating the habitability facilities; the approach is a generic one and with slight modifications could be used in automated offices:

Table 25. Example Checklist for Facility Evaluation (Veneklasen)

	OCCUPANT REQUIREMENT					FACILITY RATING					COMMENTS
	IMPORTANT				UNIMPORTANT	SATISFACTORY				UNSATISFACTORY	
PRIVACY - Auditory and Visual											
SOCIABILITY - Accomodate Conversations											
FORMALITY - Restricted Activities											
CHOICE - Control of Environment											
COMFORT - Appropriate Environmental Features											
IMAGERY - Space Depicts Purpose											
EFFICIENCY - Easy to Arrange Workspace											
ACTIVITY - Selection of Furnishings, Colors											
FLEXIBILITY - Ability to Modify											
TASK PERFORMANCE - Space Accomodates Job											
TERRITORIALITY - Personalization											
LACK OF CROWDING - Not Overoccupied											

Table 34. Analytic Approach for Relating Technology Issues to Design (Rubin and Murray (25))

	PRESENT OFFICE	AUTOMATED OFFICE	POSSIBLE DESIGN IMPACT
INFORMATION/MANAGEMENT SYSTEMS			
Record Storage & Management	Paper files	Limited paper, Electronic files	- Less space for file cabinets, changed layout - Added electronics, added cooling load
Internal mail generation & Distribution	Paper	Electronic	- Smaller mail room, more electronics
Document distribution	Typed copy	Optical Character Recognition devices (Hard copy readied for electronic distribution)	- Need for physical separation of system (Noisy), special acoustic design
Document preparation	Separated functions; Manual typing, artwork, graphics	Centralized and electronic	- Large work station for preparing documents, less space needs for visual arts
Organization of activities	Specialized and decentralized	Work stations - clerical, managerial, professional	- Change in adjacency locations - e.g., management-secretarial - More electronics and capability to access information from various sources (wiring, cooling)
Expansion of capabilities	Space set aside	More power, wiring to accomodate future needs	- Added capacity for electronics power; plan for "local" cooling
Planning activities for organizational needs	Minimal necessary	Detailed planning of systems essential, building, mgmt, communication, info.	- Much greater need for detailed architectural programming activity
POWER SYSTEMS			
Emergency Power	None	Batteries, Generator - Support for electrical equipment during outage	- Additional space, special venting systems, fuel storage, special flooring for acid, fuel runoff; fire protection, security
Wire Distribution Techniques	Conduits Under floor systems In-wall outlets	Flat wire cables under carpet Raised floors	- New floor systems - carpets - Increased size of floor/ceiling systems - Changed power loading factors-less load per local circuit, more runs - Changed needs for wire closet space - Special protection for cables
OFFICE TECHNOLOGY BASED ACTIVITIES			
Typing	Electronic typewriter	WP system	Glare free lighting, additional workspace
Communication-individual	Telephone, mail, memos	Electronic mail	CRT terminal, wiring
Filing	Paper files, individual	Centralized data base	Specialized computer facility - raised floor, clean, emergency power, less paper storage space
Facsimile production	Hands-on duplicating	Duplication at a distance - FAX machine	Specialized facility to accomodate a variety of devices, acoustic treatment, cooling
Reading	Paper copy	CRT's, microfiche	Special lighting, additional desktop area for more equipment

Table 35 provides an example of an outline of a habitability design document.

Table 35. Outline for a Typical Habitability Design Document (Brauer (36))

1. INTRODUCTION

Purpose of Document

What Document Includes and Excludes

Scope - What Projects the Design Information Applies to

Who is User(s)

How to Use (Explains Organization. Format, Applications)

Explanation of Key Terms

2. PROCEDURES

Variable depends on the purpose of the document and its anticipated users.

MCA and New Construction Process

Rennovation Procedures

Design Procedures

Space Management Methods

Procurement of Furnishings and Equipment

Site Selection and Orientation

Evaluating Alternative Facilities or Designs

Preparing Functional Requirements

for Design for Improvement Projects

3. GENERAL DESIGN INFORMATION (For a particular facility)

General Goals and Policies for a Facility and Its Design

Description of Facility users, Users, and Contents (Equipment, Material, Supplies)

Site Layout Information

General Design Information for this Kind of Facility

General Design Information for Typical Subsystems

4. DETAIL DESIGN INFORMATION

Major Category of Spaces

Typical Design Information for this Category

Specific Space Type

Users, Uses, and Contents

Subsystems and Characteristics (Blocks of Requirements, Criteria, and Guidance Statements)

(Repeat for All Space Types Within this Major Category)

(Repeat As Needed for Each Major Category of Spaces)

5. GLOSSSARY OF TERMS AND ABBREVIATIONS

6. REFERENCES

7. APPENDICES (Typical Forms and Other Special (Materials)

8. INDEX OF TERMS

Table 36. Questionnaire for Controlling Working Conditions (Grandjean (150))

With the questionnaire at hand the person supervising the work situation can consider the relevant factors systematically. A comparison with the check list of an aircraft pilot may make this clearer. Before take-off a pilot checks that all systems are functioning properly with the help of a list of questions. The check list helps him to remember all the important parts of the aeroplane. In a similar way, the questionnaire below is intended to help the responsible person to remember all the important points when creating an efficient and safe working environment.

1 Estimating the Work Load
- 11 Main Occupation.
  Occupation of secondary importance.
- 12 Is the work physically strenuous?
- 13 Does the work put great demands on skill, vigilance or perception?
- 14 Does the working environment contain disturbing factors (climate, noise, lighting)?
- 15 Does the type of work impose an extra burden on the worker (shift work, work without rest pauses, paced work)?
- 16 Does the worker carry a heavy responsibility?

2 Questions referring to Physical Stress
- 21 Position of body (sitting, standing, stooping).
  - 211 Does the position of the body demand considerable static muscular work?
  - 212 Is the working height correct?
  - 213 Are the ranges of movement of handles anatomically correct?
  - 214 Is there sufficient room for free movement?
  - 215 Does visual control of the work or the instrumental display allow a natural body position?
  - 216 Does the operation of pedals allow a natural body position?

  Questions for sedentary work
  - 217 Is the seat adjusted to the working height?
  - 218 Is the seat comfortable?
  - 219 Is a foot rest necessary?

3 Questions referring to Perception, Vigilance and Skill
- 31 Demands on perception
  - 311 Is the lighting satisfactory?
  - 312 Is the supply of information adequate and properly displayed?
  - 313 Do the size of the figures, words, symbols and scale marks fit the reading distance?
  - 314 Are the instruments, components and other structures so placed that control is easy and error free?
  - 315 Is optical magnification required?
  - 316 Is the relationship between the visual display and the controls properly designed?
  - 317 Can speech or sound signals be heard clearly; is their meaning fully understood?

- 32 Demands on vigilance
  - 321 Is attention disturbed by noise or other acoustic stimuli?
  - 322 Is attention disturbed by the activities of other persons?
  - 323 Is attention disturbed by processes at the work place?

33 Demands on skill
- 331 Does the skilled work take place under visual control?
- 332 Does the work need a long training time?
- 333 Have all conditions for the easy acquisition of automatic activity been provided?
- 334 Are the directions and sequences of required movements organized efficiently?
- 335 Is the arrangement of controls such that a natural posture is possible?
- 336 Does the manipulation of the controls require excessive force?
- 337 Are the controls adequate for the task they are required to perform?

4 Questions referring to the Working Environment

41 Light and colour
- 411 Is the intensity of light sufficient during the day?
- 412 Is the artificial lighting sufficiently bright?
- 413 Is there excessive brightness contrast in the working visual field?
- 414 Does the eye have to move periodically from dark to light areas?
- 415 Are there any reflecting surfaces at the work place?
- 416 Are the light sources correctly placed?
- 417 Is the light supplied of uniform quality (fluorescent tubes free from flicker, tubes shifted in phase, no stroboscopic effects)?
- 418 Do colours at the work place present suitable brightness contrasts?
- 419 Does the background coloration interfere with the colour coding of knobs and handles?
- 41.10 Is the colour scheme in the room quiet and friendly?

42 Environmental climate
- 421 Is the air temperature comfortable?
- 422 Are the temperatures of surrounding surfaces similar to the air temperature?
- 423 Are draughts perceptible?
- 424 Does the relative humidity correspond to the physiological requirement?
- 425 Are the heating appliance placed correctly?

- 426 Is the supply of fresh air sufficient?

Questions referring to work under hot conditions
- 427 Is the heat load tolerable?
- 428 Is the clothing suitable?
- 429 Is there an adequate supply of liquids?
- 42.10 Can the heat stress be reduced by screening or other measures?

43 Protection against noise
- 431 Does the noise disturb vigilance or intellectual effort?
- 432 Does the noise interface with speech?
- 433 Is the noise great enough to damage the auditory apparatus?
- 434 Can the noise be reduced?

Table 37. Illustrations of Questionnaire Items on Environmental Survey (Lozar & Porter (37))

WORK STATION

Your work station is the physical space in the room you and your office equipment occupy. Various aspects of your work station layout may affect your job performance. Please indicate the degree to which you agree or disagree with the following statements.

	Highly Agree	Agree Slightly	Neutral	Disagree Slightly	Highly Disagree
16. The size of my desk surface is adequate for my tasks.	___:	___:	___:	___:	___
17. The area my space occupies is adequate for my tasks.	___:	___:	___:	___:	___
18. I have enough storage space in and around my desk.	___:	___:	___:	___:	___
19. I find my work station flexible enough to meet changing requirements.	___:	___:	___:	___:	___
20. I think my work station presents a professional image.	___:	___:	___:	___:	___

ROOM

Your work station is in a room. Certain attributes of this room can be rated individually and make up your total perception of your space in the room. Please answer the following questions.

WINDOWS

51. How important is it for you to be able to see outside?

Extremely important ___: ___: ___: ___: ___: ___: ___ Not important at all

52. Do you feel having a window is a factor in your ability to do you job?

1. Yes 2. No

53. Do you feel a window:

Improves my performance on the job ___: ___: ___: ___: ___: ___ Distracts from my performance on the job

54. Can you see out of any window from where you normally sit?

1. Yes 2. No

55. If so what can you see? (circle as many as necessary)

1. trees 2. cars 3. fields 4. buildings 5. supplies 6. trash

Table 38. Questionnaire for Evaluating VDT Lighting (Zackrison (151))

NAME: ______________________________ INTERVIEWED BY: ____________________
DATE: ______________________________
OFFICE LOCATION: ________________ TIME: ______________________________

Male _____ Age _____ Health Condition: Excellent _____
Good _____
Female _____ Fair _____
Poor _____

1. How do you feel about the present lighting in your area both in terms of quantity (levels of illumination in footcandles) and quality (how does it feel under the illuminated area?)?

2. Does your area seem quiet and serene? That is, no harsh glare, no lighting distractions.

3. Explain lamp obscuration - (fixture lens obscures the lamp image outline if there is good lamp obcuration. In lenses without this quality the fluorescent tubes appear as bright lines behind the lens). Does seeing the lamp image within the lighting fixture annoy you?

4. Explain direct glare - (direct glare harsh uncontrolled lighting coming directly from the source "luminaire", directly into your eyes. This is also one form of disability glare). Do you feel there is direct glare at your work station.

5. Explain indirect glare - (indirect glare is light that is reflected into your eyes off the task). Do you feel there is indirect glare at your work station?

6. Explain veiling reflections which are caused by indirect glare - (A veiling reflection is caused by reflected light or indirect glare and can be linked to placing a veil over the task thus masking it out and rendering it more difficult to see - "see contrast rendition factor"). Do you feel there is veiling being cast on your work surface or on the screen of your CRT and/or VDT?

7. Explain contrast rendition factor (CRF) - (Poor contrast rendition factors are due to poor contrast that is caused by indirect glare casting a veiling reflection - usually a reflection of the overhead lighting fixture - upon the tasks, thereby reducing the contrast of the printed material in relation to other material "paper" it is printed on).

8. Do you feel that there is too much brightness and glare at your work station?

9. Do you feel comfortable in your lighted environment?

10. Do you feel that there is good visibility in your area by virtue of the proper intensity of lighting? (Lighting levels of illumination in footcandles is sufficient - neither too high nor too low.)

11. Does the lighting appear to harsh to you? (Too bright, too glary, distracting, too much contrast, hurts your eyes?)

12. Does the lighting hurt your eyes?

13. Are you subject to eye fatigue?

14. Are you subject or prone to frequent headaches? (Possibly the result of poor lighting quality and/or quantity, "too much or possibly too little".)

15. Does the taks appear more difficult to read towards the end of the day?

16. Do you feel you are more subject to reading, writing or typing errors towards the end of the day?

17. Do you feel your task is placed within dark areas caused by shadows being cast upon that area? (This can be caused by poor placement of lighting fixtures or the addition of bank style partitions being added within your area after the installation of the original overhead lighting system.)

18. Do you feel that your productivity level (quantity of work produced) has fallen off due to poor quality lighting and too high or too low of quantity of illumination "footcandles")?

19. How long do you work each day at this station or terminal? (How many hours a day and are they all at once or in several segments, i.e. 2-3 hour work periods?)

20. How many days a week to you work at this station or terminal?

Table 39. Checklist for Developing Human Engineering Data for a Management Information System (MIS) (Hendricks (59))

		Yes	Not applicable	Not Aware*	No*
1.	Are private offices available for personnal who conduct professional or supervisory counceling or confidential discussions on a regular basis?	☐	☐	☐	☐
2.	Have conference spaces been provided for those times when employees need to work together?	☐	☐	☐	☐
3.	In circumstances where several employees share equipment, are those employees co-located?	☐	☐	☐	☐
4.	Are the employees separated from noisy equipment such as CPUs, copiers, etc?	☐	☐	☐	☐
5.	Have office locations been chosen with regard to expected interactions?	☐	☐	☐	☐
6.	Are partitions used to screen traffic?	☐	☐	☐	☐
7.	Are all commonly used facilities centrally located?	☐	☐	☐	☐
8.	Are frequently interacting functions located on the same floor?	☐	☐	☐	☐
9.	Are the pathways to and from offices straight? (That is, are confusing spirals, curves, or dead-ends avoided)?	☐	☐	☐	☐
10.	Where an open office concept has been used, is some amount of pathway continuity present?	☐	☐	☐	☐
11.	Are the dimensions of all private offices at least 7.5 x 7.5 ft (2.3 m x 2.3 m)?	☐	☐	☐	☐
12.	Are the private offices designated so no one faces a window while working?	☐	☐	☐	☐
13.	Does each private office have a good source of illumination?	☐	☐	☐	☐
14.	Does each office have independent control of its ventilating system?	☐	☐	☐	☐
15.	Is there adequate space at the workstation for the equipment and data (printouts, microfiche, manuals, etc.) that the user needs?	☐	☐	☐	☐
16.	Is the work area adjustable so that it can accommodate comfortably the 5th to the 95th percentile of the adult population?	☐	☐	☐	☐
17.	If the CRTs, the microfiche readers, etc., are not at the immediate workstation, are they as close as possible to that station?	☐	☐	☐	☐
18.	Is the workstation adjustable so that the home typing keys are 2 inches (55 mm) below the elbow height?	☐	☐	☐	☐
19.	Are all employees trained to adjust their furniture, or is adjustment provided as requested?	☐	☐	☐	☐
20.	Are office noise levels below 45 dB(A), 37 dB PSIL-4, or 38 dB PSIL?	☐	☐	☐	☐

11.2 INTRODUCTION OF AUTOMATION INTO OFFICES

Luke (87) lists the following points as critical to the successful introduction of automation into her organization:

"1. Collect your facts, so that your method of installing equipment can be supported with numbers.

2. Start early to announce and explain the new systems, answer questions, share your plans, and generate enthusiasm.

3. Share information with both the management staff and the support staff-preferably, the same information.

4. Take it slowly. Allow time to pilot-test a few systems. Allow time for people to get used to the new idea. Again, communicate test results as they come in. The slow, careful approach always works best.

5. Notice whether, and what "grapevine" information is leaking out, and try to make the informal network positive and working <u>for</u> you.

6. Collect information as systems are installed, to assess effectiveness and pinpoint problem areas. Share the results with all involved.

7. Admit and face up to problems; find solutions to them immediately (call in experts if needed) so that the spirit and support are maintained.

8. Think of ways to generate enthusiasm and motivate the user groups, from the inception of the plan through to the refresher training and the documentation of the system procedures. Involve managers and support staff together.

9. Know when to turn each operation over to its manager (with documented procedures and with available assistance when needed)."

Riley (93) cites the following checklist as an aid to decision making and planning associated with office automation:

Table 40. Office Automation Objectives Considerations Checklist (Riley)

	Check
REDUCE WASTE (Efficiency)	
Decrease Workload	
Reduce Overtune	
Free Skilled People from Routine Work	
Reduce "Down" or "Off" Time of Equipment	
Increase Off-Lane Operations	
REDUCE COST (Economy)	
Reduce Number of Operations Performed	
Reduce Size or Quantity of Equipment	
Reduce Manhour Requirements	
Reduce Number of Reports Produced	
Reduce Distribution of Reports	
BETTER INFORMATION (Accuracy)	
Increase Accuracy of Input/Output	
Select Better Reporting Elements	
Improve Distribution (Right Data to Right People)	
Increase Precision or Capacity of Equipment Used	
Increase Flexibility or Variety of Processing Operations	
MORE CURRENT INFORMATION (Timeliness)	
Decrease Throughput Time (effective Date of Information)	
Cut-Down Process Turnaround Time	
Reduce Reproduction Service Time	
Reduce Distribution/Transmission Times	
Provide More Frequent Reports	
MORE OUTPUT FROM AVAILABLE RESOURCES (Productive)	
Increase Hardware Utilization	
Provide More Compact or Efficient Storage	
Provide Greater Compaction of Data	
Eliminate Redundant Operations	
Eliminate Unnecessary Operations	

McNurlin (18) details several characteristics that an office automation strategy ought to contain:

- Obtain top management commitment - a corporate information strategy must be formulated, with top management playing an important role. A senior executive should be a key person in advocating and directing the program.

- Choose an initial user community - a pilot program should be undertaken with a group need to communicate with one another, and be widely dispersed geographically. The managers should be enthusiastic experimenters, who will make use of the system themselves.

- A corporate information plan should be developed - the goal of such a plan should be improved organizational efficiency and better information handling. The plan should consider the following:

- Organizational factors - the effect of the automated office on organizational structure and procedures.

- Data processing - what applications are needed, what are the equipment requirements?

- Communications - internal and external requirements.

- People considerations - how to gain acceptance and support.

- Environmental factors - considerations of lighting, space, noise levels, etc.

- Implementation program - studies of managerial work, information flow, the office automation marketplace. Expand the system slowly, adding additional user groups after the pilot study. Finally, gradually expand the capabilities of the system.

11.3 ANALYSIS OF OFFICE FUNCTIONS

Office functions are analyzed by Eichorn (92) into five basic types.

1. Communications - estimates are quoted where managers and professionals spend between 65 percent and 75 percent of their time on scheduled and unscheduled meetings, and time on the telephone. Electronic mail systems are proposed as a means of increasing communications efficiency.

2. Information Storage and Retrieval - a large proportion of time is spent working with written information; reading material and then preparing responses. A good deal of the technology is focused on this area.

3. Data Analysis - computing power will allow professionals to have available the information and resources to aid in their decision making process.

4. Personal Assistance - making travel arrangements, maintaining a personal calendar and similar activities can be readily performed with the aid of a computer system.

5. Task Management - maintaining a continuous record of tasks to be performed, deadlines, and messages received may be the most critical functions to be performed by an office automation system.

Kunin (110) indicates that three categories of action must be expressed to describe the office functions.

Table 41. Office Functions to be Specified (Kunin)

1. Routine manipulations of objects. These are primarily actions concerned with the existence of objects, and include the following operations:

   - creation of a new object
   - removal of an object from the environment
   - changing of some characteristic of an object
   - transmitting an object to another site
   - placing a record of an object in a long-term archive
   - adding an object to a set
   - removing an object from a set

2. Actions that require some decision. These, primary judgment-based, actions can be further subdivided into:

   a. basic decisions, concerned with whether a single object satisfies certain conditions, including:

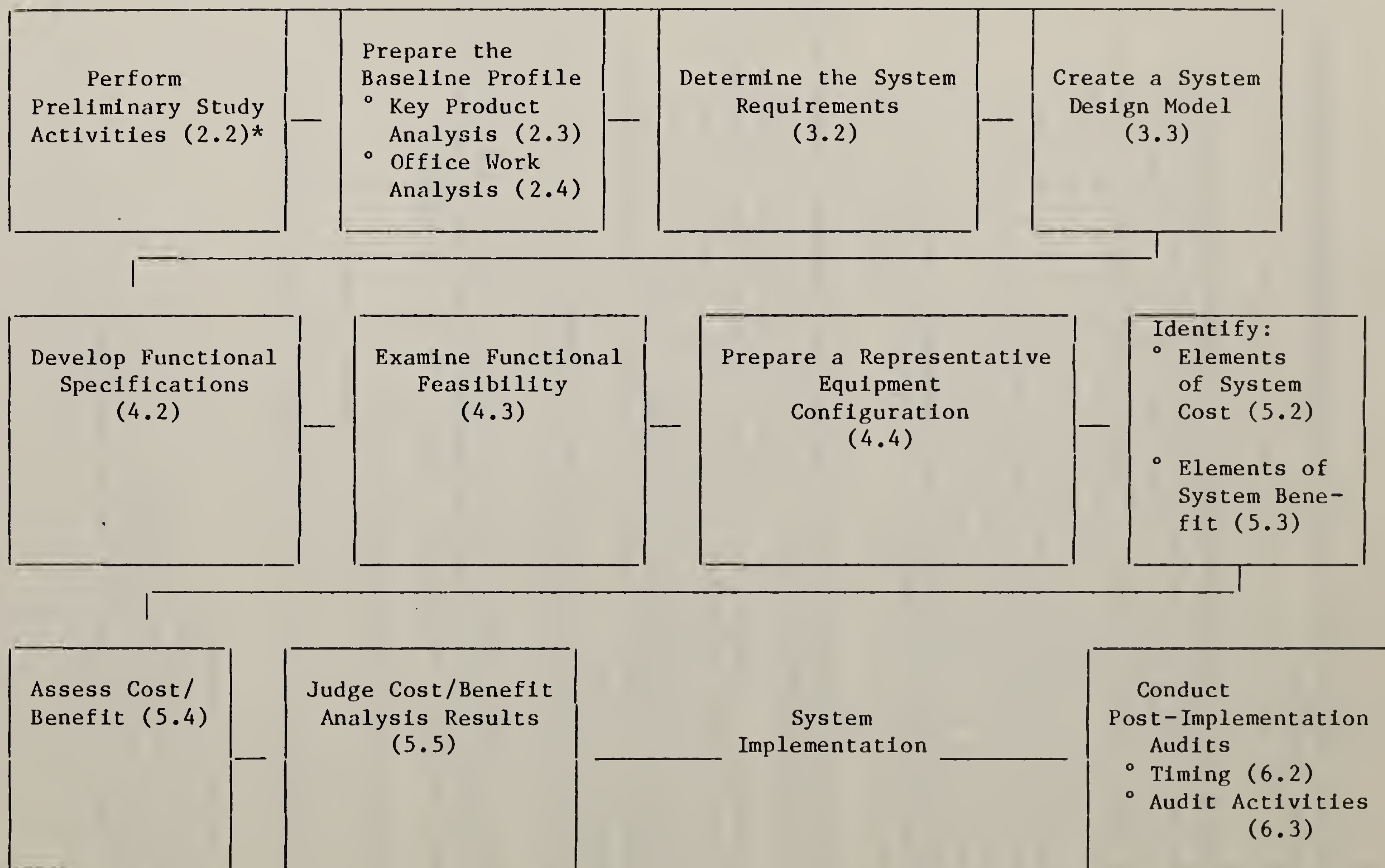
      - verifying the correctness of an object
      - approving the creation/issuance of an object (by a person with authority to do so)
      - evaluating an object and recording a judgment
      - negotiating the characteristics of an object among several parties

   b. Aggregate decisions, those made simultaneously about several objects of the same type, due to a interdependence of the decisions about the individual objects: selecting a subset of a set of objects

      - allocating objects among several users
      - partitioning a set of objects into several groups

3. Actions that concern the control of procedures and the handling of exception conditions:

   - initiating a procedure
   - terminating a procedure
   - calling a (subroutine) procedure
   - restarting an action that caused an exception
   - notifying a party responsible for handling an exception



* Section of the guideline to be referenced

Figure 26. The study methodology (NBS - 152)

Figure 27. Example of Worksheet Used to Analyze Specific Activities (NBS)

NAME ____________
DATE ____________
TOTAL HOURS ____________

WORKSHEET FOR ____________________
(Product/Activity)

TASKS (PROFESSIONAL LEVEL)	PROFESSIONAL PERSONHOURS	FUNCTIONS BY YOU (type and hours)	FUNCTIONS BY SUPPORT (type and hours)	SUPPORT TYPE FUNCTIONS
PLANNING				1. TYPING
CONSULTING				2. DICTATING
COLLECTING DATA				3. TRANSCRIBING
SORTING & EVALUATING DATA				4. FILING
PREPARING DRAFT				5. DUPLICATING
REVIEWING/REVISING DRAFT				6. DISTRIBUTING
COORDINATING				7. PRINTING
OBTAINING APPROVALS				8. COMMUNICATING
DISSEMINATING				9. DATA PROCESSING
MAINTAINING RECORDS				

Table 42. Taxonomy of Office Tasks (Conrath, et al. (82))

Code	Task	Description
P	Planning, budgeting, analyzing (future oriented)	Involves substantial cognitive activity. The emphasis is on things which have an effect on the organization in terms of establishing guidelines, constraints, etc., for future action.
D	Deciding, authorizing, approving (action oriented)	Action oriented, either reaching a decision about an action to be taken or the taking of an action, or the approval of one or the other.
E	Evaluating, controlling (task oriented)	Involves the evaluation and control of past or ongoing actions. Are things being done properly? It can also involve the coordination or review of projects.
H	Human relating, supervising, appraising, staffing, motivating (people oriented)	The management of people a general category involving the influence on subordinates and is more than just informing or talking things over with them.
M	Participating in interactive meetings (two-way communication)	The formal interactions with several people to give them ideas or to get ideas, responses, etc. from them.
I	Informing, reporting, requisitioning (one-way communication)	A one-way flow of information, data, facts, and the like. The essence is the flow of knowledge which may be useful to the recipient.
A	Advising, counselling, assisting, problem solving, acting as a liaison (limited to 2 or 3 people)	Giving advice or assistance especially with regard to problem solving. It is more than informing since there is give and take.
S	Selling, convincing, persuading (change oriented)	Trying to convince someone to do something. Using an emotional appeal or a well developed argument.
G	General administration, handling paperwork (managerial level)	Managerial tasks involving general administration and paperwork. Used when the task does not clearly belong elsewhere.
F	Completing forms, recording, logging, filing, retrieving (routine oriented)	Task is doing no more than filling in the blanks or routine search and retrieval tasks.
T	Typing, transcribing, copying (going from one medium to another)	Transcribing something into another form, and nothing more (cognitive activity is nominal).
B	Bookkeeping, accounting, inventorying (basic clerical computations)	Working with figures, numbers, especially on a rather routine level. The preparation of simple unannotated financial statements e.g.
Q	Arranging meetings and appointments, telephone calls, distributing mail (secretarial tasks)	Secretarial type tasks other than those which come under T and F. Acting as a routine go-between.
Z	Miscellaneous	Used when the task decription cannot be coded or the information given is meaningless.

11.4 INFORMATION FOR COMPUTERIZATION; FRIENDLY SYSTEMS

The following characteristics are suggested by Crenshaw and Philipose (119) for the development of a friendly user/computer system:

"Tools. Small independent tools are preferred to large ones. Each tool should carry out one and only one well-defined function. The tools should be named using common words which describe their functions.

Input commands. A single interface should control all input to a computer's operating system. This will ensure a uniform command syntax. The system should allow users to edit command lines and correct errors, either prior to entry or after detection.

Output interface. All programming tools should communicate with the user through a single output driver and, to the extent possible, make all output formats uniform. For commands with several phases, the system should indicate when each phase is completed and the user should be able to suppress these computer responses.

Extensibility. Users should be allowed to collect groups of command lines into "command files." There should be no distinction between the response needed to invoke a common file, like an editor, or a simple system command.

Context memory. A record should be maintained of user options and program status.

Error handling. No combination of user input should cause an unrecoverable error. The system should report all errors to the user through the same output driver in the uniform format. The system's error messages should be printed clearly and tell the user what is wrong.

Documentation. Extensive online documentation and learning aids should be available to the operator. Written documentation should be considered only as a secondary source of information."

Table 43. Procedure Used for Collect Functional Requirement Data (Rosenbaum (111))

	Features/Requirements	Mgrs	Prof	Admn	Corr
4.25	User can designate another person (e.g., a file administrator) to receive system messages about his files and their status.	M	M	M	M
4.26	User can restrict a document in the department or general files so that only certain individuals or certain departments can have access to it.	M	M	M	M
4.27	User can restrict certain portions of text within a document so that only certain individuals or departments can have access to the portions restricted.	I	I	I	I
4.28	User can file a document in an encoded state so that anyone who retrieves it must have the system decode it before it can be read or printed out.	M	M	M	M
4.29	User receives a notice from the system when his personal file "cabinet" allocation becomes full.	M	M	M	M
4.30	File administrator users receive notices from the system when department and general file "cabinets" become full.	M	M	M	M
4.31	System allows for the expansion of all electronic file" cabients" upon the addition of space and is transparent to the user.	M	M	M	M
4.32	User can receive a listing of his personal, department, and/or general files sorted in any order or by any index that he desires.	M	M	M	M
4.33	User can randomly search or browse file folder listings and/or document names.	M	M	M	M
B.	Search and Retrieval				
4.35	User can search for a document in any one or more of his available electronic "cabinets"—i.e., personal, department, or general, simultaneously.	M	M	M	M

Importance Codes: M=Mandatory, I=Important, D=Desirable

Stewart (118) suggests the following guidelines for the design of human-computer dialogues:

1. Documentation. Easy to use manuals are essential, as are indexes and lookup lists which serve as reference material.

2. Allowances for different skill levels of users. Individuals vary considerably in terms of their familiarity with computers at the outset, and also in terms of their speed of learning. One solutions is to require simple procedures at the outset, and then let the user advance at his own rate in the use of more powerful and faster approaches.

3. Abbreviations. Codes and abbreviations should be treated as a separate language and the listing should be readily available to all system operators. The terms used should be carefully selected to avoid inconsistency and ambiguity.

4. Layout. The layout and format of the information may be as important as the content, and should be carefully designed and tested. A good design would entail logical sequencing of information in relation to the system and the user's task. Similar items should be grouped together as a means of highlighting interrelationships of findings. The display should not be cluttered with too much information. The screen displays should be consistent with one another to simplify its use. Finally, the formats used should be as simple as possible.

5. Order. The sequence of information should be consistent with the ordering of the functions to be performed by the operator.

6. Graphics. Often this means of presenting information is more effective than text.

7. User oriented. Formats and procedures should be tested by proposed users before being implemented. The awareness and involvement in the process are both important in the design of computer systems.

8. Errors. Common errors will occur, but the system should be designed so that such errors should not have a catostrophic effect.

9. System response time. Ideally, delays should be minimized, but in general variability in the delay is more disruptive to the users than the length of delay.

10. The final general guideline is that no set of general principles will cover any particular situation. Rather, the sequence of issues covered must be considered from the standpoint of a particular user group and the activities that they perform.

DEVELOPMENT OBJECTIVES (Usability)

USABILITY ATTRIBUTES	PARAMETER CATEGORIES Means Used to Measure	Unit of Measure	Planned Level	Worst Case Level	Current Level	Remarks
a. easy to learn basic features	test sample of 5 clients using prototype	hours, score	4	6	none	MUST be able to learn
b. better & faster communication	sample task suitable for tele. conf.	hours to complete	2	4	4	a key selling point
c. logical, consistent command language	kind and rate of errors	count of errors due to confusion about design	1/hr	5/hr	?	must fit existing style of system use
d. time to recover from errors	observe log of user actions	count of errors requiring > 30 s	hold to 2/hr	more than 7/hr	1/hr in current system	field reps say of key import.
e. smooth transitions between use of new fn. and current system fn.	task set requiring use of new and old function	count actions, time, to make trans.	less than 1/10 overall time	1/3	1/10 time is currently spent overall moving between parts	
f. attitude toward continued use	interview after questionnaire	score	80%	50%	current system score 80%	word-of-mouth is key for referral selling

Figure 28. A sample of parameters for usability attributes. Each objective is established by the values chosen for the parameter category. (Bennett (117))

In a study for Owens Corning Fiberglas, an analysis of the potential use of personal computers was made by Doubler (153) table 44.

Table 44. User Goals and Measures for Personal Computers (Doubler)

Goal	Measure
Time savings	Is there an overall reduction in the time required to do tasks currently performed manually? How much?
Improved quality of information	Does the personal computer provide access to information not otherwise available?
Creativity	To what extent does the machine aid the user in developing new perspectives and ideas?
Ease of use	How long does it take to learn to use the computer and each of the program packages evaluated? How complete are the documentation and instructions provided by the vendor? To what degree is expert help required?
Timeliness	To what degree does the computer speed up the retrieval and sending information, and help the user comply with deadlines and time constraints?
Applicability	What specific tasks can be performed more effectively with the help of the personal computer? Does it meet the needs originally identified? Does use of the personal computer suggest applications not previously considered? What are the specific irritations of use?
Availability/reliability	How reliabile are the individual hardware and software components? How frequently do they fail? How rapidly can service be obtained? How much preventive maintenance must the user perform?
Communications	To what extent does the personal computer improve the user's flexibility in communication with others?
Overall impact	Does the user view the personal computer as a net positive influence in doing his/her job?
TECHNICAL GOALS AND MEASURES	
Goal	Measure
Utilization	How much is the personal computer actually used? Is sharing viable? Does usage increase or decrease over time?
Prototyping	Is vendor supplied software useful in analyzing user needs? Does it help the user express his overall requirement in more concrete terms? Does it help the professional staff design more effective applications for the mainframe?
Security	What specific security issues are raised by the use of personal computers? How can these issues be addressed?
Data integrity/redundancy	To what extent are useful data isolated from general use? To what extent are data being duplicated by individual users?
Development alternatives	Is the use of vendor supplied software an effective alternative to custom system development? Is the use of a minicomputer an effective alternative to use of the central computer system? In what specific cases?

11.5 COMMUNICATIONS AND TECHNOLOGY

Table 45. Automated Office System Components (McNurlin (18))

Information Generation	Information Distribution
Voice activated input devices	Distributed data networks
Multi-function intelligent work stations	Integrated communications (word/data/graphics/voice/image)
Two-way cable home television	Store and forward communications
Handwriting entry devices	Computer message systems
Graphical input devices	Smart facsimile devices (combined with OCR)
Word processing	Computerized branch exchanges (CBX)
Portable radio telephone	Micropublishing (computer typesetting from microforms)
'Intelligent' telephones with digitized voice	Intelligent copiers/printers
	Automatic typesetting
	Multi-media tele-conferencing
	Electronic bulletin boards
	OCR interfaces
	Electronic funds transfer systems (EFT)
Information Storage	**Information Query**
Electronic message files	'Personal assistant' services via software
Computer output microfilm and updatable microforms	Bibliographic search services
Multi-media digitized storage	Automated training techniques
Automated personal calenders	Interactive graphics
Automated inforamtion storage and retrieval systems	Data base management system (DBMS)
Automatic message content indexing systems	Electronic pointers (light pen mouse)
	Specialized information services
	Simple English query/retrieval languages
	Decision support systems

A major motivation for networking is the sharing of such resources as communications facilities, computer facilities and information itself. Network design can influence the ease with which resources can be shared, thereby influencing the amount of sharing that occurs. Information sharing has the most far-reaching implications in organizations - i.e. the facility with which information can move across the boundaries of individual applications. Figure 29 illustrates how this information is compiled in a system devised by Licklider and Vezza (154).

NETWORK CHARACTERISTICS

NETWORK APPLICATIONS	1 Bi-Directionality	2 Freedom from Error	3 Efficiency Despite Burstiness	4 Low Cost Per Bit	5 Connectivity	6 Information Rate	7 Security	8 Privacy	9 Authentication	10 Reliability	11 Full-Duplex	12 Priority	13 Speech Capability	14 Picture Capability	15 Insensitivity to Distance	16 Shortness of Delay	17 Uniformity of Delay	18 Broadcast Capability	19 Mobility	SPACE FOR ADDITIONAL CHARACTERISTICS								SUBJECTIVE RATING OF IMPORTANCE OF APPLICATION
BASIC																												
Transmission																												
Storage																												
Processing																												
Information																												
COMMUNICATION																												
Mail, Messages																												
Duologue																												
Teleconferencing																												
Speech																												
Encrypted Speech																												
Still Pictures																												
Moving Pictures																												
NEOPAPERWORK																												
Telework																												
Augmentation																												
Task Management																												
MANAGEMENT																												
M.I.S.																												
Modelling																												

Figure 29. Importance coefficients of network characteristics for various classes of network applications (each cell entry should be subjective rating of importance on a scale from 0 (Low) to 5 (High)

The framework for defining a communications network is based on a highly layered series of protocols developed by the International Standards Organization (ISO), called the Open System Interconnection (OSI) protocols (155). The OSI architecture defines seven layers of communications:

"1. The Physical layer. This defines the electrical and mechanical interfaces to the network. The physical layer specifies the particular signaling means (baseband vs RF for example), the modulation technique adopted, station identification addresses, etc.

2. The Data-Link Level. This is where the actual packet formats are established, along with the particular access control mechanism used to regulate use of the physical network. Data are encapsulated in packets that contain physical addressing information, error detection, etc.

3. The Network Layer. This level determines how to get a message from one network to another one, since many paths may exist. It may use several intermediate steps to get information to its ultimate destination.

4. The Transport Layer. This provides another level of connections between network entities. It manages the connections and segments messages into smaller pieces that the network can support. It may also be involved in error and flow control.

5. The Session Layer. This is used to set up and break communications paths across the network and manage the exchange of data. It is responsible for multiplexing and demultiplexing messages, managing the sequencing and priority of these messages, and providing the needed buffers.

6. The Presentation Layer. It is primarily responsible for making data available to the Application layer in a meaningful fashion. It takes care of protocol conversion, data unpacking, translation, or encryption.

7. The Application Layer. It provides for the identification of users and services, and is responsible for initiation and reliability of data transfers, as well as general network access, flow control and recovery. Utility programs may perform network file-transfers, terminal to network support, etc."

12. GLOSSARY

ANALOG COMPUTER - A calculating machine that operates with numbers represented by directly measurable quantities (as voltages, resistances, or rotations).

ANTHROPOMETRY - The study of human body measurements, especially on a comparative basis.

AI - Articulation Index

ARPANET - A set of autonomous, interconnected, and independent computer centers which use a standard transmission method to permit interactive resource sharing among all participants--set up by ARPA (Advanced Research Project Agency).

ARTICULATION INDEX - A numerically calculated measure of the intelligibility of transmitted or processed speech. It takes into account the limitation of the transmission path and the background noise.

ASHRAE - American Society of Heating, Refrigerating, and Air Conditioning Engineers, Inc.

BASEBAND - The band of frequencies occupied by all transmitted signals used to modulate the radio wave that is produced by the transmitter in the absence of a signal.

BATCH PROCESSING - A technique that uses a single program loading to process many individual jobs, tasks or signals for service.

BROADBAND - A band with a wide range of frequencies.

BUS - A length of coaxial cable, to which microcomputer stations are attached.

CENTRAL PROCESSING UNIT - The computer at the center of an on-line system which performs the processing according to the applications package.

CIS - Computer based information system.

CMBS - Computer based information system.

COAXIAL CABLE- - A transmission line in which one conductor is contained inside and insulated from an outer metal tube that serves as a second conductor.

COM - Computer output microfilm

COMMAND LANGUAGE - A type of dialogue in which the user formulates control entries with minimal prompting by the computer.

COMPUTER MAIL	- The transmission of messages using computer systems.
CPU	- Central processing unit
CRITICAL SUCCESS FACTORS	- Those activities most important in performing major job functions.
CSF	- Critical success factors
DATA BASE MANAGEMENT SYSTEM	- General purpose programs that accept data in a format determined by the user, process, the data, the output it in a desired format.
dB	- Decibel
DBMS	- Data base management system
DDP	- Distributed data processing
DECIBEL	- The unit of sound intensity.
DECISION SUPPORT SYSTEM	- A computer information system designed for managers and professionals, using simplified interactive programming with acess to one or more data bases.
DIALOGUE	- A structured series of interchanges between a user and a terminal. They can be computer-initiated (question and answer) or user controlled by a command language.
DIGITAL SWITCH	- Interconnecting data, word processing, and telephone equipment by a digital PBX.
DISABILITY GLARE	- Glare resulting in reduced visual performance and visibility.
DISCOMFORT GLARE	- Glare producing discomfort; not necessarily interfering with performance
DISTRIBUTED DATA PROCESSING	- Sharing of computing among several computers at different locations.
DP	- Data processing
DSS	- Decision support systems
EDP	- Electronic data processing.

ELECTRONIC MAIL	- An electronic system using communications lines, computers, CRT and hard copy terminals to transmit documents and messages to individual addresses.
ERGONOMICS	- A subject are which deals with the interaction of person/. machine and person/environment issues.
ETHERNET	- An example of a distributed processing network, with several microcomputers; it is based upon workstations designed for a given function, with data processing capability.
FDM	- Frequency division multiplexing
FIBER OPTICS	- Very thin strands of glass, used to transmit information by means of light pulses.
FIRMWARE	- Routines wired into the computer as part of the circuitry.
FLOPPY DISC	- A small mylar data storage device, resembling a phonograph record.
FRONTEND SYSTEM	- The part of the computer system that interprets what the user specifies, and interacts with the "background" of the system, which performs the detailed operations desired.
HABITABILITY	- The impact of the environment on the behavior of building users with respect to their welfare, task performance, and job satisfaction.
HID	- High intensity discharge
IBD	- Institute of Business Designers
IEEE	- Institute of Electrical and Electronic Engineers
IES	- Illuminating Engineering Society
INTELLIGENT TERMINAL	- Terminal with limited programming capabilities such as format creation and parameter definition.
IS, I/S	- Information system
ISO	- International Standards Organization
JOYSTICK	- Manual input device for graphic display consoles, which allows the user to specify 2 dimensional or 3 dimensional coordinates.
KNOWLEDGE WORKER	- A person with a major responsibility for developing, analyzing and/or acquiring information, e.g., professional, manager.

LAN	- Local area network
LOCAL AREA NETWORK	- Systems of computers and peripheral devices linked together in adjacent offices or buildings.
MAINFRAME	- The central processing unit of a large computer system.
MANAGEMENT INFORMATION SYSTEM	- A computerized procedure for providing managers with immediate knowledge, information, and data needed to make decisions, direct people, and regulate operations to better attain organizational goals.
MANUAL PROCESSING	- Any data processing operation performed by hand.
MENU	- A type of dialogue in which the user selects from a number of displayed alternatives.
META LANGUAGE	- A set of symbols and words used to describe another language (in which these symbols do not appear).
MICROGRAPHICS	- The capture, retrieval, and display of miniaturized, high-resolution photographic images containing either textural or graphic information.
MINICOMPUTER	- A computer whose physical size is between a microcomputer and a full size computer.
MIS	- Management information system
MICROCOMPUTER	- Used to described the small physical size of a computer
MULTIPLEX	- to interleave or simultaneously transmit two or more messages on a single channel.
NODE	- A single station in a local area network
OA	- Office automation
OCR	- Optical character reader
OPTICAL CHARACTER READER	- The reading and identification of characters optically, under computer control.
PABX	- Private automatic branch exchange
PACKET SWITCHING	- The internal operation of a particular type of data communications network which uses software to dynamically route messages from source to receiver.
PBX	- Private branch exchange

QWL	- Quality of working life
SCIENTIFIC MANAGEMENT	- Analysis of tasks into smallest possible standard components; "time-and-motion" studies to increase productivity
SEMANTICS	- The meaning of language intended by the originator of a message.
SOFTWARE	- Computer programs, rules, procedures, and associated documentation concerned with the operatio of a computer-based system.
SOUND TRANSMISSION CLASS	- The preferred single figure rating scheme designed to give an estimate of the sound insulation properties of a partition. Used when speech and office noise constitute the major noise problem.
STC	- Sound transmission class
SYNTAX	- A set of rules specifying which forms of the language are grammatically acceptable.
TASK/ AMBIENT LIGHTING	- A combination of task and ambient lighting in a given area, with the ambient lighting being lower in intensity and complimentary to the task lighting.
TASK ANALYSIS	- Used to determine the psychological and physical factors essential to the adequate performance of a task.
TERRITORIALITY	- The perception of a person or a group that they possess a given place to the exclusion of others.
TIMESHARING	- A function of software that enables parcelling out access to the processor among input/output devices such as CRT's often by means of dial-up ports.
TWISTED PAIR	- A cable comprised of two small insulated conductors twisted together without a common covering.
TWX	- A network of telegraph-grade communications lines and terminals used to transmit messages.
USABILITY	- The ease of learning a task, and ease of use.
USER FRIENDLY	- Requiring only a limited amount of experience, knowledge or training to operate.
VALUE-ADDED NETWORK	- Transmission networks used to facilitate communication among terminals and computers.

VDT	- Video display terminal
VDU	- Visual display unit
VEILING REFLECTIONS	- Regular reflections superimposed upon diffuse reflections from an object that partially or totally obscures the details to be seen, by reducing the contrast.
WHITE NOISE	- An acoustical stimulus composed of all audible frequencies at the same intensity with random phase relations between them; it sounds like "shhhhh".
WORD PROCESSING	- The keyboarding, editing, and printing of documents on a system that includes hardware and software in many instances.
WORKSTATION	- The general physical environment in which the user works. It includes computer terminals, source documents, desks, chairs, and lighting.
WP	- Word processing

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NBS-114A REV. 2-8C)

U.S. DEPT. OF COMM. BIBLIOGRAPHIC DATA SHEET (See instructions)	1. PUBLICATION OR REPORT NO. NBSIR 83-2784-1	2. Performing Organ. Report No.	3. Publication Date November 1983

4. TITLE AND SUBTITLE

THE AUTOMATED OFFICE - AN ENVIRONMENT FOR PRODUCTIVE WORK, OR AN INFORMATION FACTORY?: A REPORT ON THE STATE-OF-THE-ART

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6. PERFORMING ORGANIZATION (If joint or other than NBS, see instructions)

NATIONAL BUREAU OF STANDARDS
DEPARTMENT OF COMMERCE
WASHINGTON, D.C. 20234

7. Contract/Grant No.

8. Type of Report & Period Covered

9. SPONSORING ORGANIZATION NAME AND COMPLETE ADDRESS (Street, City, State, ZIP)

General Services Administration
Washington, DC 20405

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)

This study is a report of research findings and recommendations covering topics which influence automated office design. The subjects covered are: office design, office information systems, organizational factors, ergonomics, technology and communications. Advances in technology, coupled with the explosive growth of office-based work have resulted in the automation of many offices. To date, technology has provided the major impetus for automation, with mixed results. Systems frequently do not meet the needs of the end-user because of the lack of appropriate planning. Design issues are particularly neglected during planning, resulting in problems with the visual, thermal, and acoustic environment in many offices. These effects are particularly detrimental since many office automation, management, and design experts agree that the quality of the environment is especially important in the electronic office - to offset the impersonality of many office tasks, and changes in work procedures resulting in limited social interaction with colleagues. These issues are discussed as they relate to the development of design guidelines and criteria for automated offices. The report contains an extensive bibliography, dealing with the topics cited above.

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

Acoustic privacy; design criteria; ergonomics; lighting; office automation; office design criteria; quality-of-life; space planning; thermal comfort; VDT's (video display terminal); work station.

13. AVAILABILITY

X Unlimited
☐ For Official Distribution. Do Not Release to NTIS
☐ Order From Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.
X Order From National Technical Information Service (NTIS), Springfield, VA. 22161

14. NO. OF PRINTED PAGES

207

15. Price

$19.00