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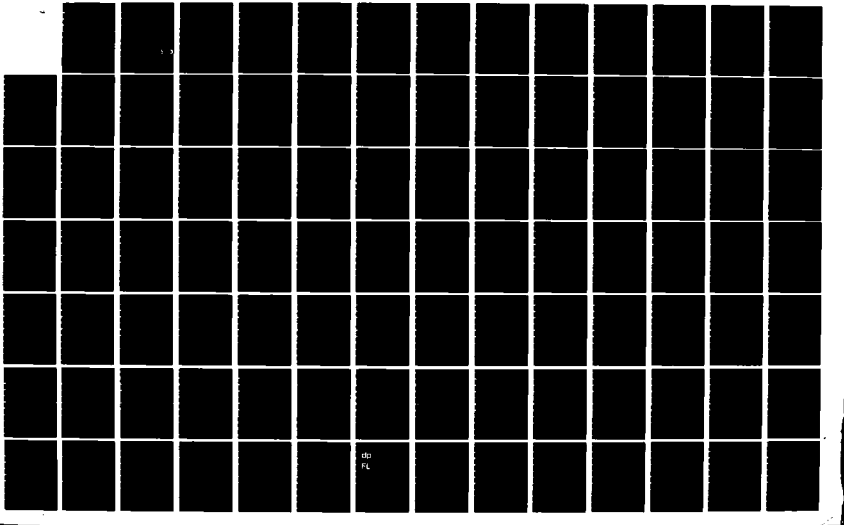

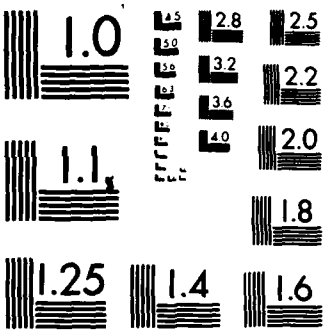

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HUMAN ENGINEERING GUIDELINES FOR MANAGEMENT INFORMATION SYSTEMS

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With minor revisions to Chapters 2, 9, and 10

United States Army Materiel Development and Readiness Command
A joint publication of
Management Information Systems Directorate - Human Engineering Laboratory

Enclosed you will find a copy of our recently completed publication of Human Engineering Guidelines for Management Information Systems which you requested. If you have any comments, suggestions or criticisms, please communicate this to us. The feedback that will be received is being relied on as a primary means to improve this document.

Thank you for your time and effort. Your questions and comments should be directed to CPT Daniel E. Hendricks, Ph.D. The address is Director, US Army Human Engineering Laboratory, ATTN: DRXHE-CS (CPT Hendricks), Aberdeen Proving Ground, MD 21005. If you need more copies, please send a letter to the above address.

Enclosure

DEPARTMENT OF THE ARMY
HEADQUARTERS, US ARMY MATERIEL DEVELOPMENT AND READINESS COMMAND
5001 Eisenhower Avenue, Alexandria, VA 22333

CHANGE 1
HEL GUIDELINES

9 June 1983

HUMAN ENGINEERING GUIDELINES FOR MANAGEMENT INFORMATION SYSTEMS

This change updates chapters 2, 9, and 10 and corrects minor errors throughout.

Human Engineering Guidelines for Management Information Systems, 1 November 1982, is changed as follows.

a. Remove pages and insert new pages as follows:

Remove pages —	*Insert pages —*
cover	cover
ix	ix
xi	xi
xiii	xiii
1-1 and 1-2	1-1 and 1-2
2-1 through 2-8	2-1 through 2-7
3-1 through 3-6	3-1 through 3-6
3-17 through 3-19	3-17 through 3-19
4-1 and 4-2	4-1 and 4-2
4-7 and 4-8	4-7 and 4-8
5-11 and 5-12	5-11 and 5-12
9-11 and 9-12	9-11 and 9-12
10-1 through 10-6	10-1 through 10-5
10-9 and 10-10	10-9 and 10-10
10-15 through 10-22	10-15 through 10-22
B-1 through B-4	B-1 through B-4
B-7 and B-8	B-7 and B-8
C-5 through C-8	C-5 through C-8
GL-1 and GL-2	GL-1 and GL-2
GL-7 and GL-8	GL-7 and GL-8
Index 1 and Index 2	Index 1 and Index 2

b. File this change in front of the publication.

(DRCMS-EB)

FOR THE COMMANDER:

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PREFACE

These guidelines are intended to be an aid for the inclusion of human factors considerations in the design of Management Information Systems (MIS).

A brief review of the tasking of the US Army Human Engineering Laboratory (HEL) to work on human factors aspects of management information systems will explain the evolution of these guidelines.

The US Army Materiel Development and Readiness Command (DARCOM) is faced with a problem of continuing growth in workload combined with constrained or decreasing numbers of personnel. Like many other corporate entities, DARCOM has decided to accelerate the growth of computer utilization in order to increase the productivity of the workforce. In addition to increased computer utilization, there is emphasis toward distributive processing. Distributive processing places computer power in the hands of the functional user which allows the user to interact with (manipulate) the data. Unfortunately, empirical evidence indicates that expenditures on computers are not accompanied, necessarily, by the expected rises in productivity.

In part, the reasons for this lack of expected increase in productivity can be found in problems arising in the broad area of the interaction of people with automated management information systems. The field which studies this human-machine interaction is usually called human factors or human engineering. The DARCOM Directorate for Management Information Systems (DMIS) requested the HEL to investigate human factors aspects of current MIS systems. The hope was that knowledge of problems in current systems would lead to improvements in these systems and prevent duplicating these problems in new systems.

HEL began the investigation by using semi structured interviews and observations at seven DARCOM installations covering a wide variety of MIS applications, to obtain a composite picture of DARCOM MIS users and problems in human-computer interaction. MIS users, for this study, were defined broadly as those who design and program systems, those who are involved in the preparation or direct input of data into a computer, those who receive or obtain information from a computer system, and those who manage computer systems.

At each site, individual interviews were conducted by one of a team of 3 to 5 HEL psychologists and engineers. The number of personnel interviewed ranged from 30 to 75 MIS users at each of the sites.

The semi-structured interview was designed to elicit both personal data and information concerning each employee's MIS rated tasks and the problems encountered during these tasks. Each of the interviews took 30 to 60 minutes and was conducted at the individual's worksite. Among other information the workers were asked to demonstrate what they prepared for the computer, how they obtained data from the computer, and how they used the data or outputs received.

The paper resulting from this research presented selected personnel data relevant to the design of computer systems and problems of human computer interaction divided into eight areas: the system design process, system downtime, training, input, data manipulation or retrieval, output, the work station, and communication. (Hendricks, D.E., Man Computer Interaction in DARCOM. A paper presented at the 1980 AMEDD Psychology Symposium at Walter Reed Army Medical Center, Washington, DC, October, 1980.) Appendix A contains a list of these problems.

With an overview of system problems and user characteristics, the research team combined that information with the results of an extensive literature search to develop these guidelines for inclusion of human factors considerations during system development or system improvement.

GUIDELINE USE

The guidelines discussed here do not offer simple solutions to the multiple problems affecting the interaction between a human operator and a computerized management information system.

Checklists provided at the end of each chapter are intended to serve as a starting point for the system designer. Familiarity with the expanded guidelines is a requirement for the person responsible for human factors considerations — the human factors advocate. A human factors advocate is necessary to provide input on such things as implications of various design choices, estimates of cost-benefit ratios, and suggestions on how problems may be remedied. Not only must the advocate be an expert in his field, he also must become knowledgeable in the system being designed. The user evaluation questionnaire (Appendix B) should be used in evaluating *existing* systems to identify specific areas for improvement. An analysis of the existing problems will facilitate the use of the guidelines.

These guidelines are not static, but should reflect research, user experience, and technology changes. These guidelines will be updated periodically. You can influence their evolution if you will take the time and effort to inform us of any suggestions or criticisms you may have. An evaluation sheet is provided for your convenience. All responses will be acknowledged, and valid suggestions will be incorporated in subsequent updates.

EVALUATION OF: Human Factors Guidelines for Human-Computer Interaction in MIS

Factors	*Ratings*			
	Above average	*Average*	*Unacceptable*	*Specific example(s) for unacceptable rating*
1. Technical accuracy	_____	_____	_____	_____
2. Validity of recommendations	_____	_____	_____	_____
3. Completeness	_____	_____	_____	_____
4. Usability	_____	_____	_____	_____
5. As compared to other guidelines	_____	____	_____	_____

What additions, corrections, or deletions to the guide would you suggest?

Do you have any suggestions concerning format?

Name: _____ Organization: _____

Address: _____ Telephone #: _____

Send to:

Director
US Army Human Engineering Laboratory
ATTN: DRXHE-CSS (MIS Guidelines)
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ACKNOWLEDGEMENTS

We would like to thank publicly the many individuals who contributed to this publication: John Gilbert, former Director, Directorate for Management Information Systems (DMIS), DARCOM, for initiating the effort to increase the impact of human engineering on DARCOM computer systems and for continuing to support our efforts; Dr. John Weisz, Director, Human Engineering Laboratory (HEL), for deciding that the laboratory could make a significant contribution in this area, and assigning part of his limited resources to this task; Dr. Robin Keesee, former team leader, Display and Logistics Team, HEL, for developing the initial plan for HEL involvement; John Stephens, Chief, Combat Services Support Directorate, HEL; Richard Camden, team leader, Logistics System Team, HEL; John Smith, Chief, Materiel Readiness Systems Division, DMIS; Lt. Col. C. O. Walters, Executive Officer, DMIS; Lt. Col. Michael Fairhead, Deputy Director, HEL, for their invaluable support, guidance, suggestions, and constructive review of the various drafts; Colleen Dixon, administrative assistant, HEL, for word processing efforts above and beyond the normal call of duty, and Donna Coale, a clerk typist, HEL, for superb typing support; Joyce Watlington and Danette Barranco, librarians, HEL, for their exceptional support. Our special thanks to those reviewers both in private industry and the military community who struggled through a voluminous draft and offered invaluable suggestions and comments: and also to Jack Harpool, Associate Professor of Data Processing, University of Akron, for his formal suggestions and help in rewriting many of the sections. Finally, our thanks to Arthur Welch, Automated Logistics Management Systems Activity (ALMSA), whose editing corrected many of the problems of earlier drafts.

This product is the result of a cooperative effort by the Directorate for Management Information Systems and the Human Engineering Laboratory. We also would like to thank the many other organizations who contributed to this effort.

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CHAPTER 1

INTRODUCTION

Human engineering, also known as human factors, human factors engineering, engineering psychology, or ergonomics, is based upon the assumption that the design of man-made devices, systems, and environments can enhance or degrade their use by people. This scientific applied discipline emphasizes the human as one component of the system or environment. Human engineering is a young developing discipline cutting across such areas as engineering, physiology, medicine, anthropology, and psycho

In the past, the data processing industry has focused on the most efficient of central processing units and storage media. This has meant running batch oriented systems with little, if any interaction until output products were delivered. The relative neglect of human engineering was justified high cost of the technology and the fact that computers were used by a relatively small group of specialists. In recent years, personnel costs, and user friendliness have become the important factors as systems are being designed for interactive processing. Computing costs have decreased and the number of people interacting with computers has increased tremendously. The recognition of these changes has led to these guidelines.

The human components of a computer system too frequently have been bent, stapled, and mutilated in order to adapt them to the vagaries of the computer. Early inclusion of human factors requirements and specifications in the design process allows for adequate consideration of human performance capabilities and limitations. Concern with human factors only after a system has severe problems limits the options available for correcting these problems. Therefore, we recommend that a human factors specialist or advocate be included in all phases of system design and redesign.

Human factors application to management information systems (MIS) design is still somewhat of an art in some areas. Applications depend upon the skill of the human factors specialist in combining knowledge of system requirements with the specifics of the guidelines to produce an MIS system which minimizes user problems. The application of these guidelines will not always lead to simple answers or solutions. Exercising the guidelines may lead to several candidate solutions or implementations with no clue as to which is best for this particular application. A solution in this case might be a small pilot test to examine the merits of the proposed approaches. Testing a large sample is not always necessary. Samples of from 2 to 5 persons may be used to identify or screen items which will be given to a larger sample. Typically, experienced users differ from naive users in what they require from the system and in how they use the system. If both naive and experienced users will use the system, both groups should be represented in pilot tests.

The individual guidelines that follow are the result of evidence from empirical studies, case histories, accepted practices, and logical arguments. Since they incorporate many existing guidelines or standards, the variety of supporting information is unavoidable.* Decisions had to be made concerning the scope of the guidelines and what to include and exclude. The guidelines are not intended to cover either graphics applications or the special considerations of continuous monitoring, because of rapidly developing technology and a lack of empirical data. Personnel selection and job design also are beyond the scope of these guidelines. Decisions in these areas often reflect philosophical views rather than logical conclusions based on empirical data, and may entail attempts to change the behavior and attitudes of managers throughout the system.

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* For example, Chaikin (1976) states that the criteria for "MIL-STD 1472: Human Engineering Design Criteria for Military Systems Equipment and Facilities" were based on research data, population sterotypes (turn wheel clockwise to make vehicle go right), group consensus and arbitrary standardization. His explanation of arbitary standardization is worth noting. He uses as an example the standardization on the color gray for color panels. The color gray was not proven by research to be the best panel color. Gray was widely used and acceptable as regard to reflection, finish, and provision of contrasting background for labeling. An extensive research program to select the optimal color did not appear under these circumstances to be cost-effective. Therefore, the choice of the color gray was somewhat arbitrary, but it did not violate any known human data or criteria and did provide an acceptable standard.

The structure and format of these guidelines are based on the experience of several recognized guideline developers. The only documented experiences we found were those of Chaikin and his associates in the development of military standards and Meister and his associates in their studies of engineers in the design process.[1,2,3] The standards used in preparing these guidelines are intended to insure:

(1) accuracy;

(2) a minimum of verbal material;

(3) sufficient illustrations to support or clarify the text;

(4) referenced empirical evidence, historical data, or logical arguments in support of each guideline where this is possible.

(5) that guideline applications are specific and clearly worded.

Finally, we recognize that this document is a summary of what is known *now* about human engineering as it is applied to data processing systems. Accordingly, the three-ring loose leaf binder was chosen as the most convenient way to keep the document current with future revisions.

CHAPTER 1 REFERENCES

1. Chaikin, G., Human Engineering Specifications and Standards: Payoffs and Pitfalls, *Technical Memorandum 21-76*, May, 1976. AMCMS Code 672716.11.H700011, USAHEL, APG, MD.
2. Chaikin, G., Human Engineering Design Criteria — The Value of Obsolete Standards and Guides, *Technical Note 13-78*, November, 1978, AMCMS Code 612716. H700011, USAHEL, APG, MD.
3. Meister, D., and Sullivan. D. J., *Guide to Human Engineering Design for Visual Displays*, Bunker Ramo Corp., 30 August 1969.

CHAPTER 2
GENERAL DESIGN CONSIDERATIONS

The purposes of this chapter are to:

- ***Identify the steps that are followed in the system design process. (i.e., MIS Design Model).***
- ***Explain the basic guidelines that are the essential building blocks of any system.***

GENERAL

Any attempt to develop guidelines includes assumptions. In this section, we attempt to make these assumptions explicit and to clarify how these assumptions affect the use of these guidelines.

In order to apply the guidelines to the design of a computer system, it is necessary to have a model of the system design process. A very general model of the management information systems design process is shown in Figure 2-1.[1]

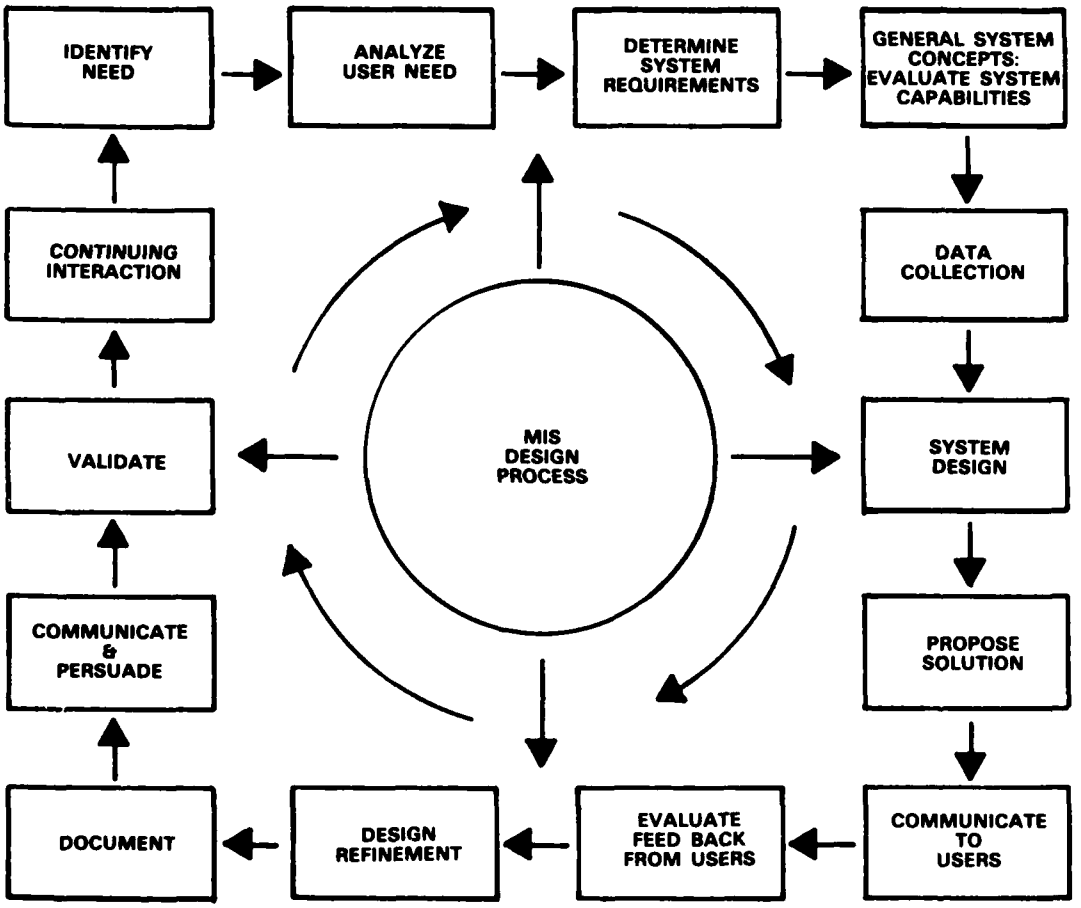

Figure 2-1. Model of the MIS design process.

The management information systems design process begins with the *recognition of a need* for a system and the *establishment of requirements* for what the system is expected to do. After interaction between developers and user managers to clarify what the system requirements will be, some *general system design* is initiated, based on the available resources. This design should be specific enough to guide the gathering of data from users-managers and user operators that will be used in the *detailed design*. Once the design is completed, the *user-manager and user-operators* are again *consulted*. The designers explain how the system will work and how *input affected the system design*. Based on this new information, there may be further comments from the users that will lead to *refinements* to the *design*. The *dialogue* between users and designers *should continue* until the system has been implemented and is operational. This model presents several problems that need to be discussed, most of which involve communication.

COMMUNICATION

One problem which is not unique to MIS development traditionally has been the problem of the user specifying the requirements for the system while not having a solid foundation in the capabilities available (computer technology in this case). This problem is aggravated in MIS areas because of the speed of the technological advancements and the increasing number of software systems and data base management systems which are available. This usually results in imperfect requirements, established by someone representing the user, being taken by the system designer and translated into a system architecture.

On the other hand, the system designer usually is not a functional expert and may have some difficulty in interpreting the requirements. Designers often have little access to how similar problems have been solved within other systems. Compounding these problems are the complexity and interrelatedness of many systems. Because of the substantial technical hurdles that have to be overcome, the design process often becomes centered upon building a system that performs the technical functions and ignors human factors considerations or shunts them aside. In reality, after the technical problems are overcome, the human factors considerations will become a driving factor in establishing the usefulness and productivity of the system.

A related problem is that the programer may interact only at the manager level and not gain knowledge of the data input, correction, or update problems, and what limitations these place on the system. *Users must be identified and defined in as many distinct ways as they appear and the requirements they represent must be kept uniquely defined and supported throughout the development process.* A frequent underlying and erroneous assumption is that we know who the users are.

Another important aspect of communication is feedback to the users. Feedback from the designers to the users allows a check as to whether the designers understood the problems expressed by the users and whether the users perceive that the solution corrects the problem. Users often receive little or no feedback and feel that their suggestions have not been seriously considered.

The final aspect of communication is continuity, that is, it is a continuing process among the interested parties that should continue even after the system is operational. Channels of communications should be maintained to handle new problems or new requirements as they arise. Systems rarely remain static; as systems evolve it is essential that system managers continue to communicate with system users.

USER ATTITUDES

Following are some basic considerations concerning the user and operation of the system.

User attitudes toward the system have begun to be recognized as a key determinant of system performance. Meldman states that, "If people don't like the system it won't work."[2] Since most people need their jobs, they will not quit if the system frustrates them. However, they just will not put in as much effort, and will be less productive then they could be. Some people may take direct action against the computer system. Dowling, in a sample of 40 installations, found that 45% had experienced some form of computer sabotage.[2] Even though Dowling does not mention purposeful uncooperation or avoidance of the system, it is logical to assume that these were even more prevalent.[2] On the other hand, positive user attitudes can significantly contribute to system performance. User attitudes can dramatically effect learning and performance with interactive systems. It has been shown that personnel with negative attitudes commit more errors and take longer to learn a system than those with neutral or positive attitudes.[1]

Resistance to a new system can be minimized by participation of all levels of system users in system design, briefings of all users on the system, and minimizing initial system errors. Although system

managers are involved in the design process by specifying requirements, information from system users at the data input level is usually not obtained. If the problems of the current system are not identified they may be repeated in the new system. If users contribute information and receive feedback as to how that information influenced the system design, they are more likely to have positive perceptions concerning the new system.

Users should be told to expect errors in the system when it first becomes operational. If provision is made to correct problems in a timely manner, or at least to communicate when these problems may be corrected, users are more likely to develop or maintain positive attitudes toward the system.[4]

Users are valuable sources of information but the information obtained from them should be evaluated in the light of empirical evidence. User's experience and opinions should be used in design of a system when it does *not contradict* empirical findings. users may not be able to describe the problems they encountered in a system because of their lack of meaningful comparisons or their adaptation to these problems over a period of time. Likewise, users preference is not a reliable basis for predicting performance on various tasks.[5]

The importance of remote interactive users finding the system available and responsive when they try to access it cannot be emphasized enough. Availability avoids both frustration and lost man-hours.[4] Excessive delays, inconsistent highly variable response times, or long system response times also cause lost man-hours and contribute to feelings of frustration. The adverse affects of system overload were poignantly demonstrated by several examples in a survey of system problems. Operators could perform a whole days work in a couple of hours by using the system before normal work hours. That is, an operator could accomplish 4 times as much work when there were adequate system response times.[6]

EASE OF USE

Another desirable aspect of any system is the ease with which it can be used. Ease of use is a desirable characteristic, but difficult to specify and quantify. It includes such things as: (1) proportion of population that can learn to perform a task, (2) length of time for user population to reach a certain level of proficiency, (3) errors per unit time or number of operations, (4) amount of time or number of operations to recover from system failures or to correct errors, (5) exasperation responses per unit of time or number of operations, and (6) attitude of users toward the system.[7] Each of these can and should be measured and analyzed to increase the probability that problems will be detected; the data gathered will provide a starting point from which possible fixes can be determined Much of the data necessary could be gathered by having automatic monitoring of dialogues and by having users respond to problem forms (for an example of such a form, see Appendix C).

Automatic monitoring provides feedback to system managers concerning the operation of their systems and should allow accurate specification of system performance and possible identification of system problems.[8,9,10] Monitoring of system and user can include such things as system acknowledgement time, system response time, user delay time, user transmission time, frequency of command, frequency of errors, errors per command, requests of help per command, etc. The terminal could also be used to present questionnaires, to collect and to analyze the data.

Obviously there are costs for the programing, storage, and computer time involved in monitoring the use of a system. It is difficult to compare these costs against the implicit costs of not collecting data or having an effective feedback system. Although the implicit costs may be difficult to quantify, on a qualitative level it is obvious that feedback is necessary both for the specification and correction of system problems.

ON-LINE SUGGESTIONS

An on-line complaint-suggestion provision allows the user to remain at the terminal while informing the system manager of a problem. The operator may become upset when faced with a problem but may be able to relieve some frustration if there is a convenient, simple way to communicate that there is a problem and the nature of the problem to the system manager. The user probably will be motivated to report the problem, and with the problem on the cathode ray tube (CRT) having just occurred, the user should be able to give an accurate description of the problem. This provision could be a valuable aid to system managers especially if they reinforce such behavior by acknowledging receipt of the information and indicate what can be done and where it will be done.[11]

WORKLOAD

Workload is difficult to define in terms that allow accurate measurement. It involves some combination of the physical or mental effort expended in performing

tasks and the quality of the task. If workload is too high, performance is degraded and there may be a recovery period required before performance recovers. If there is an underload, the user may get bored.[12]

Tomeski[2] has pointed out that the nature of the work is an especially important aspect of workload.[13] He tells of a budget analyst who was responsible for preparing budget forecasts. After automation, his role was reduced to little more than that of an automaton, placing numbers in certain boxes on preprinted forms. The interesting work was done by the computer, leaving only dull tasks for the analyst. The analyst soon became inefficient at this task, and began complaining. It became obvious that the role of the human in forecasting needed to be re-examined. There are many solutions to this problem, such as completely automating the forecasting or creating a more meaningful role for the analyst.

Work should be divided between employees and the computer to take advantage of their capabilities and limitations. Employees should be given tasks that require interpretation of the data, while computers should perform tasks that require rapid, rigorous, and repetitive operations. In many cases, task analysis of user positions are required to achieve this goal.

Software should minimize the difficulty of operator tasks.[14] Control input should be made as simple as possible, particularly for tasks requiring real-time responses, and should permit logical task sequences with a minimum of control actions to complete the task.[14]

METHODS

A perspective that focuses on the methods of human factors evaluation used during the various stages of the design or redesign and implementation processes can be seen in Table 2-1. This model is the ideal situation. Often time, cost, and/or manpower will not allow for full implementation.[15]

Table 2-1. A model for human engineering evaluation of system design.

Method	*Purpose*	*Typical use*
Requirement specification discussions	To obtain an outline of what the new system is expected to do and how it will differ from the current system.	When a system is proposed, it is necessary to obtain at least a preliminary list of what functions are to be accomplished with this system. This begins the dialogue among those concerned with the system; that is, the designers, managers, users, and operators. The dialogue should continue throughout the system's life. Elicitation of views and inclusion in the design process of not only designers and managers, but also users and generators will help foster positive attitudes toward the new system.
Literature search	To obtain information available concerning past and current functions of this system and similar systems.	Members of the design team can often profit from documented experiences with the system or similar systems. Problems identified can then be eliminated or ameliorated, and positive aspects can be incorporated into the new system.
User, operator, and manager interviews questionnaires	To define more specifically the proposed system and to determine how the current system actually functions	When a system is being designed or redesigned, it is desirable to ask people, who are using the system or similar systems, questions concerning such areas as the system's adequacy as an aid in performing their tasks, the ease with which the job can be done, and whether there are special problems that occur with the present hardware, facility, or system.

Table 2-1. A model for human engineering evaluation of system design--Continued.

Method	*Purpose*	*Typical use*
Human system observation	To further define the dynamic and environmental factors associated with the system.	Although interviews of those involved with the system may include demonstrations, it is advisable to plan for and formalize these observations. Observations should include all the tasks performed that relate either directly or indirectly to the system. It is especially useful to watch trainees being taught to use the system.
Personal operation experience	To provide the designer with "hands-on" experience with the system.	Whenever possible, the designers should actually use the current system or one similar to the one to be created in order to get a better understanding of the needs and problems which users have pointed out or which they have observed.
Time and motion study	To measure task performance and identify critical task conditions.	Useful for systems in which worker production is a significant factor; i.e., in which an increase in rate of output is the primary objective of the new system. This method provides quantitative information which may help establish priorities for design and procedural improvement.
Detailed design drawing review.	To verify human interface compliance with good human engineering practice.	Systematic analysis of detailed design drawings is essential to prevent oversights of human-system interface problems. This is critical because of the probability that changes have not been reviewed by the human engineers on the design team.
Develop a transition plan	To develop a sequence of steps that will allow for an orderly transition to the new system by avoiding as many problems as possible.	A plan is needed to have an orderly changeover to the new system. This plan should include such things as training personnel and installing and testing of new equipment.
Prototype testing	To examine the operating effectiveness of the system under actual conditions	Whenever practical, a prototype of the system should be tested prior to full implementation of the system. Such tests should include personnel who typify the actual user population. The ultimate question is whether typical users can and will operate the system as planned. Quantitative measurement of human testing performance should be accomplished whenever the work flow of the system is critical

SECURITY

The key to security is personnel who are trustworthy and always aware of security issues. Ignorance, apathy, and frustration can be as dangerous as deliberate dishonesty. When implemented, security methods should not be intricate or burdensome. Personnel do need initial training and periodic reminders concerning security.[16,17] The reader is referred to Automated Systems Security, AR 380-380, for specific security guidance and regulations.

SAFETY

Many concerns about the safety of CRTs have been publicized, and it is important that factual information be given to CRT users. These concerns basically involve two issues: radiation diseases or damage, and visual symptoms and damage. The radiation levels emitted by a CRT are very low compared to current occupational exposure standards. The National Institute for Occupational Safety and Health has stated that CRTs "do not present a radiation hazard to the employees working on or near a terminal."[18] Other researchers have declared that: CRTs DO NOT cause cataracts or other radiation associated diseases.[18]

There is no known way that CRTs can cause visual defects since CRTs CANNOT stimulate the growth of the eye, increase the power of the optical components or change the strength and pliability of the ciliary muscles.[19] Nevertheless, some people will experience symptoms of eyestrain or visual fatigue that are related to their work at the terminal. Eyestrain or visual fatigue is by no means a new problem, yet there is neither a satisfactory explanation of the origin of the pain or discomfort, nor a reliable measure of eyestrain or fatigue.[20] Nevertheless, most of the symptoms can be accounted for by ocular defects, working conditions, or inadequate office design and equipment.

In tasks that are predominantly visual, any defect in the correct functioning of the eyes may cause symptoms of eyestrain, blurred vision or headaches; all of which may worsen as the task is prolonged. Since working at a CRT is considered a demanding visual task, these symptoms are more likely to occur if there is a visual defect. Research on the vision of workers has found that up to one-third of the personnel given visual tests have uncorrected or insufficiently corrected defects of vision.

Additionally, problems have been associated with glare and reflections on the CRT screen; flicker of the screen; poor image quality; inadequate adjustment of the screen keyboard or chair; inadequate space; and poor arrangement of the office. These factors are covered in the chapters on legibility, input devices, and the work station. The guidelines that follow recommend that the CRT image should be clear and stable; the visual environment should be carefully designed to provide adequate but not excessive illumination; a relatively glare-free working environment and luminance relationships of approximately 10:3:1 (Room; desk; CRT). Screen angle, keyboard height and the user's chair should be easily adjustable *and* adjusted. The user's work station needs to be designed based on human factors principles rather than be a result of haphazard acquisition and placement of equipment.

It is generally recommended that after every two hours of continuous CRT work, the user switch to some other work for 10-15 minutes to rest the eyes and counteract fatigue. Empirical support for this two-hour standard has not been found. Furthermore, the definitions of what constitutes resting the eyes include looking at relatively distant objects, doing any other work that does not involve an illuminated screen, performing eye exercises, and closing the eyes. Since there are no reliable physiological measures of eyestrain, it is unlikely that empirically based guidelines will be forthcoming soon.

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CHAPTER 2 CHECKLIST

	Yes	Not applicable	Not known *	No *
1. Have the potential users been identified and contacted for requirements?	☐	☐	☐	☐
2. Has the system been examined in its entirety from data sources, input, manipulation; and, finally, to use of the output?	☐	☐	☐	☐
3. a . Have problems with the current system or way of doing things been identified?	☐	☐	☐	☐
b. Can these be remedied?	☐	☐	☐	☐
4. Have the users been told to expect problems when the new system is implemented?	☐	☐	☐	☐
5. a. Have mechanisms been provided for users to make suggestions or complaints?	☐	☐	☐	☐
b. Do these mechanisms minimize the effort by the users, and provide feedback to the users?	☐	☐	☐	☐
6. Does the system have automatic monitoring capability so that user performance data can be gathered?	☐	☐	☐	☐

System Designer
Signature _____ Date: _____

Approved by: _____ Date: _____

User Acceptance: _____ Date: _____

* Answers in these two columns require some action to obtain information or justify departing from the guidelines.

CHAPTER 3
DIALOGUE AND DISPLAY

The purposes of this chapter are to:

- ***Provide guidance to insure that the interactive screens displayed are designed to aid in fast and accurate entry of data.***
- ***Outline screen display guidelines that should be considered in the design of interactive screen displays for various types of data and inquiries.***

Section I. DEVELOPMENT

GENERAL

Before the dialogue and display formats can be resolved, the designer must know what the output is to be and what input is needed to produce it. Application modeling, including a user-designer iterative review process examining screen format and content is becoming a recognized step in the design process. At this point, the task as it is being done and its relationship to other systems must be reviewed so as to minimize the required input. Finally, the dialogue frames must reflect how the user now requests, and responds to, such information.

A flow chart of dialogue frames for all transactions should be developed. Pilot tests with typical users are useful in illuminating trouble spots in the dialogues. In addition, using functionally-knowledgeable pilot subjects will give some indication of how ultimate users will react to the dialogues.[1,2,3] A graphic design expert may be helpful in designing legible, readable, and understandable dialogue frames.[4]

There are numerous types of dialogues. The best source for a classification and description of dialogues is found in Martin.[3] Most dialogues can be thought of as being one of four basic types or some permutation or combination of these basic types.

TYPES OF DIALOGUES

The four basic types of dialogues are: computer initiated and guided, form filling, menu selection, and programing-like statements.

Advantages of the computer initiated and guided format (fig 3-1) are that the computer tells the user what to do for each entry, and the user needs little training. The disadvantages include its slow response time, inflexibility, and higher cost.

Type in USER ID _____
Press CR

Type in PASSWORD _____
Press CR

Type Mode Desired Press CR

Figure 3-1. Example of computer initiated dialogue.

The form-filling format (fig 3-2) also requires little training, but is not very flexible.

Stock-number _____ SIC _____

Noun _____ UI _____ DMD _____

U/Price _____ Tot-Reg

Figure 3-2. Example of a form-filling dialogue.

The menu selection format (fig 3-3) requires little training and is designed so that the user has only to recognize the correct option rather than to recall it as in the form-filling format. It is limited in scope, and is not the most efficient use of the telecommunication network, and is probably too slow for an experienced user.

Pick one:	***GPSS***	***GPSS-Transfer***
1. FORTRAN	Pick one:	Pick one:
2. PL/I	1. Advance	1. Fractional
3. ***GPSS***	2. ***Transfer***	2. Pick
	3. Unlink	3. Unconditional
First screen	Second screen	Third screen

Figure 3-3. Example of a menu selection dialogue.

(Note that the option(s) already selected are displayed in a conspicuous manner so that the user has a selection history to review as current selection is made.)

The format that is the most concise, flexible, and powerful is the dialogue using programing like statements and a restricted set of commands. For example:

Select accounts over $10,000 from 1975 to 1980.

Offsetting these advantages is the training required for the operator to learn both the commands and correct command statement formats.

Section II. DIALOGUE DESIGN PRINCIPLES

DIAGNOSTICS

Computer programs should be designed to allow specific types of failure to be diagnosed early. That is, one should be able to distinguish program errors, equipment failures, and operator errors. Further, the program should allow for orderly shut down and the establishment of check-points (synch-points) so restoration can be accomplished without loss of computing performed to date.[5]

LABELING

- Each individual data group, message, or frame should contain a descriptive title, phrase, word, or similar device to designate the content of the group or message.
- Labels should be located in a consistent fashion adjacent to the data group or message they describe. The relationship of the label to the group or message being described should be clearly visible.
- Labels should be highlighted or otherwise emphasized to facilitate user scanning and recognition. The technique used should be easily distinguished from that used to highlight or code emergency or critical messages.
- Labels should be clearly worded to avoid confusion as to whether the label is for a data entry field, a control option, a guidance message, or for other displayed material.[6]
- Labels should be unique to avoid confusion.
- When presenting a list of user options, the label ought to reflect the question being posed to the user.[5]

DISPLAY FORMAT DESIGN

- Display formats should be designed to provide optimum transfer of information to the user using information coding, grouping, and appropriate information density.
- Although there should be a standard format for data texts and tables, provision should be made to allow the user to modify these formats for personal use only; however, it should not affect the use of this data by other users.[5]
- Normally information should be displayed statically on the screen rather than scrolled. When information is scrolled, it is more difficult to understand or reorganize.[7]
- If text is intended to be scanned, 35 characters per line columns (like those in newspapers) are preferred.[7]
- If detailed reading of the text is the primary task, reading efficiency is increased if a 70-character rather than a 35-character line is used. The maximum character line length for efficient reading has not been determined.[7]

Grouping

Information should be placed in groups to permit the user to associate or compare like classes of information. Techniques includes:

- right or left justification of columns to establish boundaries of group areas,
- spacing between groups and within groups to maintain information relationship and group boundaries,
- lines between group areas or under group headings, and
- location of items to be compared on a character-by-character basis directly one over the other.[5]

Enumerating

When enumerating, each statement should start on a new line, indenting where appropriate.[8] For example,

Poor:	**Acceptable:**
Advantages, easy to use, fast learning, minimum errors	Advantages Easy to use Fast learning Minimum errors

DATA PRESENTATION

Data should be presented to the operator in a readily usable and readable format. Requirements for transposing, computing, interpolating, or mentally translating into other units or numerical basis should be avoided. When practical, data should be presented to conform to the rules below:

- When five or more digits or alphanumerics are displayed, and no natural (i.e., population stereotyped) organization exists, characters should be grouped in blocks of 3 to 4 characters each. If a series is to be 10 units, then the structure should have distinct groups of 3, 4, 3, instead of no form of grouping.[12] For example,

Poor:	Acceptable:
A624156317	A62 4156 317

- Groups should be separated by a minimum of one blank character.
- When data fields contain a naturally occuring order (e.g., chronological), such order should be reflected in the organization of the field.[12]
- Identical data should be displayed in a consistent, standardized manner, irrespective of the source of origin. In cases where double meanings are possible, specify the intended meaning.
- When presented in tabular form, alphanumeric data should be left justified, numeric data should be left justified by decimal point. For example

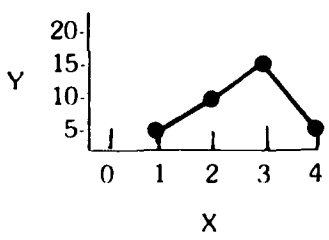
Alphanumeric	Numeric	Decimal
A67 8948 340	8437	48.28
A67 8948 341	28	8.0
A78 5643 849	439	6.8
B69 4328 657	26	4.333

- Lists should be vertically aligned and left-justified. Indentation should be used for subclassifications.
- Numerical data, which must be scanned and compared to or used with other items in a list, should be presented in *graphic* or *tabular* form. For example:

Tabular

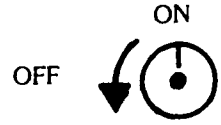
X	Y
1	5
2	10
3	15
4	5

Graphic



- For graphic displays, the axes of graphs should always be labeled and should be subdivided as needed with marking so that the values of data points are easily discernable.[8]
- When appropriate, use of illustrations such as line drawings should be used to supplement the text.[8] For example:

Poor:	Acceptable
Turn the knob counter clockwise to shut off.	Turn the on/off knob counter clockwise to shut off.



- Tabular data should be displayed in a left-to-right, top-to-bottom array. When tabular data extends over one page vertically, the columns should be labeled identically on each page. Tabular data should not extend horizontally over one page.[5]
- All displayed data necessary to support a user activity or sequence of activities should be grouped together.[5]
- The use of hyphenation should be minimized.
- Periods should be placed after each item selection number, at the end of a sequence, and where necessary for clarification.
- Each individual field should be labeled. The user should not have to rely on contextual cues to identify a field.
- Text paragraphs should be separated by at least one blank line.[5,8]
- Frequently appearing command and subcommands should appear in the same place on the screen. When words are deleted from lists, consider not compressing the list, but leaving blanks instead so the user will find the command at the same place on the screen.
- In a classification system, identifiers that are short in length should be used to aid short-term memory. Where possible, alphabetics can be used to increase its range. Short-term memory has a limited capacity and errors increase dramatically for series with more than seven characters.
- When grouping alphabetic characters, make use of acronyms or short, meaningful character strings rather than randomly selected characters that have little systems relevance. In the case of a

small classification system it may be advantageous to have vowels between consonants to ease pronounciation. For example:

Poor:	Acceptable:
L2XW 2631	Jeep 2631
TNK 2573	Tank 2573

- One or two characters in a series which are different from the rest will be most easily remembered. The unusual characters can be used to either carry particularly significant data, or to counteract the serial position phenomenon. A combination of numbers and letters can be arranged in patterns to mark off different fields without having to resort to other symbols or space. However, groups are more easily recognized if spaces are provided. For example:

Poor:	*Acceptable:*
A54L91Z82	A54 L91 Z82

- When documentation is used to carry or check data, the distance between the two data sources should be minimized. This can be achieved in a number of ways including using paperwork with slits or transparent areas to get the original data near the new copy area.

For selected (and limited) very important data, a technique to provide automated comparison of data strings with correction and/or reentry capabilities should be provided.

Random letters are more difficult to recall than random numbers.[9]

Numbers and letters randomly distributed among positions are associated with more errors than when assigned fixed positions in the sequence.[9,10]

Signficant Digits

- The system should not display numbers with more significant digits than are justified by the computational accuracy of its number holding procedures and the basic data.
- The system should round the output to the last significant digit and *not truncate* it.[11] For example if the computed number is 8.988.

Poor:	Acceptable:
Truncated to 8.98	rounded to 8.99

CURSORS

- Cursors are used to indicate the position in the display where the next character will appear. They are also used to indicate the location of specific items of information in the display or the position at which one or a group of characters is to be inserted or deleted, or where a command is to be given.[12]
- A box or block type cursor with optional 3 Hz blinking is recommended.[13]
- A cursor should:

  be easy to locate at random positions on the display.

  be easily tracked as it is moved through the display.

  not interfere with the reading of the symbol that it marks, and

  not be a distraction or impair the searching of the display for information unrelated to the cursor.[12]

POSITIONING CURSOR

- Upon appearance of each frame the cursor should be positioned to the first character position of the first input field.[14] As an input field is completed, the cursor automatically goes to the first character position of the next field.[14]
- Formats should be organized to minimize positioning movements of the cursor to specify where the keyed entry is to go. Align entries to minimize search time. For example:

Poor:		Acceptable:	
ID	Name	ID	_____
Number	Quantity	Name	_____
		Number	_____
		Quantity	_____

- When position designation is the sole or prime means of entry, a direct pointing device (e.g., a lightpen) is preferrable to incremental stepping or slewing controls (e.g., keys or joystick).[6]

FIXED LENGTH ENTRIES

If a fixed length word or collection of characters is to be entered, underscores should be used to indicate the number of characters in the sequence. For example: Enter serial number _____.[8]

USER'S STATUS

Information detailing the user's status should be displayed. If a user is editing a file, both the file name and the edit mode should be displayed.[8] For example:

Poor:	Acceptable:
directly from the original manuscript	Edit-Modeling directly from the original manuscript

HISTORICAL FILE

The user should be able to request job status at anytime to see what was done. A "historical" file of user actions would satisfy this requirement. If such files could be stored they would provide reference material for the user.[8]

MENUS

- The displayed menu should include only options appropriate for the particular step and the particular user.

If the items are brief, menu items for either logical or space considerations may be arranged in two columns.

DISPLAY LEVELS

When an operator must key through multiple display levels, the system should:

- be designed to minimize the number of levels required,
- provide priority access to the more critical display levels,
- provide the user with information about the current position within the sequence of levels,
- insure similarity, whenever possible, between display formats at each level, and
- supply all data relevant to making an entry on one display frame.[5,8] For example, (3 consecutive frames).

Pick one:	***GPSS***	**GPSS-*Transfer***
1. FORTRAN	Pick one:	Pick one:
2. PL/I	1. Advance	1. Fractional
3. ***GPSS***	2. ***Transfer***	2. Pick
	3. Unlink	3. Unconditional

CODING

Coding should be employed to differentiate between items of information and to call the user's attention to changes in the state of the system. Several types of coding are discussed below.

- Flash coding (blinking) should be employed to call the user's attention to mission critical events only. The flash rate should be between 3 and 5 flashes per second with equal on/off times. Event acknowledgement or flash suppression keys should be provided.
- Brightness intensity coding should be primarily used to differentiate between an item of information and adjacent information.
- Pattern coding should be employed to reduce operator information search time.
- Location coding should be employed to reduce operator information search time.
- Symbol coding should be employed to enhance information transfer. Symbols should be analogs of the event or system element they represent or be in general use and well known to the users. Where size difference between symbols is employed, the larger ought to be at least 1.5 times the height of the smaller, with a maximum of three size levels.
- Color coding, where appropriate, should be used to differentiate between classes of information in complex, dense, and critical displays. The color selection should agree in principle with those specified for other visual tasks. Care should be taken to ensure that all terminals have color capacity and that various types of color blindness are taken into account.[5]

NECESSARY INFORMATION

The information displayed to a user, such as symbols, abbreviations, display codes, alerts, and alarms, should be limited to that which is necessary to preform specific actions or to make decisions.[5]

INFORMATION DENSITY

- Information density ought to be held to a minimum in displays used for critical task sequences. A minimum of one character space should be left blank vertically above and below critical information with a minimum of two character spaces left blank horizontally before and after.[5]
- Putting too much on the screen leads to confusion and increased error rate. The screen should contain only data elements which the user may need. Even then, the screen may appear congested. A common practice is to designate certain areas of the screen for certain types of information. There are several ways of giving the perception of structure: blank spaces between rows or columns; different surrounding lines — solid, dashed, dotted.[5,15,16]
- It may be desirable to automatically remove data no longer needed on the screen.[5]
- Users should be able to temporarily or permanently eliminate irrelevant items from the display.[5]
- The screen should not be broken into many small windows or viewports.[5]
- Whenever possible, users should be able to see the whole page on which they are working.[5]

MULTIPLE PAGES AND MOVING DATA

- Items continued on the next page(s) should be numbered relative to the initial page(s). A message should indicate that the data is on several pages.[8]
- The user does not need to know whether scrolling or windowing is being done. The simple command FORWARD and BACKWARD is all that is needed.
- If CRTs do not offer windowing or scrolling, they should offer the facility of page scrolling or paging, which is the electronic equivalent of reading the text (calling the text from storage) page by page or pan scrolling, which is a more continuous form of roll scrolling and is similar to the scanning movement of credits at the end of a television program.[12]
- When the user is scrolling, the present and maximum locations should be displayed on the viewable portion; e.g., "lines 24 thru 46 of 428 lines."[8]

MODE OF ENTRY

Frames should be designed so that the user can use one mode of entry as long as possible before having to switch to another (e.g., switching from a light pen to a keyboard).[8]

TEXT DISPLAY

Running text should be displayed in both upper and lower case font.[8]

NEW COMMANDS

If a new format, procedure, or command is defined that replaces an old one, the user should be given a brief description of the new one whenever he attempts to execute the old one. For example, after sending the command "Control S" which no longer exists, the user would receive this message, "control S has been changed to control X; for more information type CONTROL X EXPAND".[11]

ENTRY STATUS

- The display or data entry system should indicate to the operator either acceptanace or non-acceptance of the input, or delay due to the computer.
- The computer ought to signal the user immediately that an entry has been received or accepted. A long pause can cause the user to wonder if the data or command was entered correctly, properly transferred to the computer, received by the computer, or if the system malfunctioned.
- Ideally, the system should also periodically inform the user what the computer is doing: working on the problem, waiting for a port, or whatever is happening, and when to expect a message. An indication should be given to the user every 30-60 seconds.[5,8]

INFORMATION CONTROL

- Information the user must have to select or enter a specific control action should appear on the screen when the control action becomes available.
- Control actions to be selected from a discrete set of alternatives should have those alternatives displayed at the time of selection.
- The current value of any parameter with which the user is interacting should be displayed.
- Values displayed concerning nomenclature, units of measure, sequence of task steps, or time phasing should not mislead the user.

CONTROL INPUT DATA DISPLAY

- The location and presence of control input data entered by the user ought to be clearly and appropriately indicated.[5]
- When a user is prompted by the system for a parameter with a pre-defined default, the default should be shown.[8]

STORAGE

- The users should be able to leave the system and store their work so that upon re-entry at a later date they can resume where they left off.[17]
- Users should be able to maintain files or libraries of their own subroutines, programs, defaults, and language equivalents.[11]

COMBINE COMMANDS

Users should be provided with the capability to combine several basic commands into a procedure, give this procedure a name, and use this name as an executable command. The new multi-function command will save time by allowing the user to execute one command minimizing user-system interaction.[18]

MEMORY BANK

The system should have a backup memory which would store all data disregarding changes or deletions for 72 hours. This could be done by sending any edited or deleted file to storage automatically. This would handle such problems as the system crashing while working on a file and losing portions or the total

file. It would allow the user to look at a printout and correct errors by referring back to the original.[8]

RESPONSE TIME

In many problem-solving situations, inquiries into a system are lock-stepped. The user must await the answer in order to develop the next command. Time intervals between input and response output tend to be dead time for the user.[19]

Decreases in mental efficiency occur in sudden drops rather than in linear fashion when delays exceed a given point. The major categories of response time can be seen in Table 3-1.[20]

Sets of adequate system response times which are dependent on the actions performed can be seen in Table 3-2.

Table 3-1. Major categories of response time.[20]

GREATER THAN 15 SECONDS

In general, delays greater than 15 seconds rule out conversational interaction. If delays of more than 15 seconds will occur, the system should be designed to free users from the physical and mental captivity of waiting for the system, so that they can turn to other activities and get a displayed answer at their own convenience. A message at the start of the delay period giving the expected length of processing is desirable.

GREATER THAN 5 SECONDS (5 TO 15 SECONDS)

Response times that are greater than 5 seconds are generally too large for an interactive conversation since they require operators to retain task information in short-term memory. Operators subjected to such delays tend to be very inhibited in problem-solving activity and frustrated in data-entry activity. After a major "task completion", the operator is prepared to wait longer. An operator is usually content to await a response for a period up to 15 seconds after keying an EXECUTE command to complete a major task. Longer waiting periods, however, can lead to unproductive behavior or a shift from one task to another. In either case, the operator's problem-solving train of thought may be lost.

2 SECONDS

A period exceeding 2 seconds can produce difficulties for those users working at a high level of concentration. Two seconds can be a *long wait* at a terminal when the user is mentally and emotionally committed to complete the task being performed.

ALMOST INSTANTANEOUS

A response (displayed character or auditory tone) to the pressing of a key needs to be almost instantaneous (i.e., less than 0.2 seconds for discussion purposes).

Table 3-2. System response times[19]

Activity or function	*Maximum response (Time in seconds)*
1. Systems activation	
a. Engaging ON button	2.0
b. Request to contact the system	5.0
2. Response to control activation such as change in control force after moving a key past a detent position, the appearance of a line when a light pen is used as a stylus, or the appearance of a printed character on the screen or page	0.1
3. Feedback	
a. To mechanical insertion of ID card	0.5
b. That ID number is correct in length and correct in alphanumeric format	0.5
c. That ID is accepted	2.0

Table 3-2. System response times[19] (Continued)

Activity or function	*Maximum response (Time in seconds)*
4. Request for service (from command to beginning of the display)	
a. Simple (frame already exists)	2.0
b. Complex command	5.0[a]
5. Error feedback	2.0
6. User intervention in an automatic process	
a. Acknowledgement of command	2.0
b. Able to execute command	5.0

[a] If processing will take more than 15 seconds, give the user an estimate of the length of time needed for the system to comply with the command(s), and provide an acoustic signal when the terminal is ready for the next command.

RESPONSE TIME VARIATION.

Response time variation has been shown to be as detrimental as long response times.

- For response times of 0-2 seconds, the maximum variability should be ±5%.
- For response times of 5 seconds, the maximum variability should be ±10%.
- For response times greater than 5 seconds, the maximum variability should be ±15%.[21]

HARDCOPY

- The user should have the capability to obtain a paper copy of the exact contents of the alphanumeric or digital graphic display.
- If the printer output will be printed away from the user, a print confirmation or denial message should be displayed. The contents of the screen should not be changed as a result of the print operation.[5,8]

DIALOGUE CONTINUATION.

Dialogue frames should never leave the user with no further available action. Dialogue should provide next steps, or alternatives.[14]

PROGRAM TRANSMITTAL.

One user should be able to send or transfer control of a program, file, or message to any other user.[11]

AUTOMATIC LOGOUT.

Interactive systems should allow some specified time, (e.g., 5 to 15 minutes) between keyboard actions before automatic logout unless a longer period is requested by the user. This could reduce the number of ports required to service a given number of users.[22]

MEANINGFUL MESSAGES.

The system should not assume the reader is familiar with system codes, e.g., at log-on provide average system response time rather than some other obtuse information. The user should be provided adequate information for making decisions.[8] For example:

Poor	**Acceptable**
User Load 64.3	User load high; 2 min delay for simple command

TIME AND MONEY ACCOUNT.

The system should tell the user upon request how much time has been used since the beginning of the session, or since some specified date, and the approximate charges accrued. In some cases, knowing how much money or time remains in the account is useful.

OVERLAYS

- Mechanical overlays, such as coverings over the keyboard or transparent sheets placed on the display, should be avoided.
- Electrical overlays are acceptable. Overlays should be clearly identified as such. They are best used for instructional purposes.[5,8]

AUDITORY SIGNALS

Auditory signals should be considered when computer response to a user request is greater than 15 seconds. This allows the user to focus on other tasks until processing is completed and another action is required. The following general standards define

characteristics for non-critical auditory signals when used in association with interactive visual display:

- the auditory signal should be used to alert and direct the user's attention to the appropriate visual display;
- the optimum type of signal ought to be carefully evaluated, so that while not startling or interfering with others in the immediate area, it is readily noticed by the user. Because of variable background noises, the intensity should be adjustable;
- the intensity, duration, and source location of the signal should be selected to be compatible with the acoustical environment of the intended receiver as well as the requirements of other personnel in the signal area;
- auditory signals should be intermittent in nature, allowing the user sufficient time to respond. The signal should be automatically shut off by user response action;
- auditory signals should be sounded by system failures;
- non-critical auditory signals should be capable of being turned off at the discretion of the user.[23]

CHAPTER 3 REFERENCES

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CHAPTER 3 CHECKLIST

	Yes	Not applicable	Not known *	no *
LABELS				
1. Do the directions to the user always precede the list of choices or required actions by the user?	☐	☐	☐	☐
2. Does each individual data group, message, or frame contain a descriptive title, phrase, word, or similar device to designate the content of the group or message?	☐	☐	☐	☐
3. Are labels located adjacent to the data group or message they describe?	☐	☐	☐	☐
4. Is the relationship of the label to the group or message being described unambiguous?	☐	☐	☐	☐
5. Are the labels highlighted to facilitate user scanning and recognition?	☐	☐	☐	☐
6. Is the method used, easily distinguished from that used to highlight or code emergency or critical messages?	☐	☐	☐	☐
7. Are the labels constructed so that the user does not think that some action must be done to the label?	☐	☐	☐	☐
8. Are the labels unique among themselves to avoid confusion?	☐	☐	☐	☐
9. Does the label reflect the question being posed to the user when presenting a list of user options?	☐	☐	☐	☐
DISPLAY FORMAT DESIGN				
10. Are the display formats designed to facilitate information transfer to the user?	☐	☐	☐	☐
11. Are there fixed formats for:				
a. Data?	☐	☐	☐	☐
b. Text?	☐	☐	☐	☐
c. Tables?	☐	☐	☐	☐
12. Can the user personalize the formats?	☐	☐	☐	☐
GROUPING				
13. Are like classes of information grouped to permit the user to associate or compare like classes of information?	☐	☐	☐	☐
14. Are group boundaries clearly indicated?	☐	☐	☐	☐
15. Is spacing used to maintain information relationships?	☐	☐	☐	☐
16. Are the items to be compared on a character by character basis directly over the other?	☐	☐	☐	☐
17. Is each item started on a new line when enumerating?	☐	☐	☐	☐
DATA PRESENTATION				
18. Is data presented in a usable and readable format? (There should be no need to transpose, compute, or mentally translate into other units.)	☐	☐	☐	☐

(Date presentation--cont'd)

	Yes	Not applicable	Not known *	no *
19. If groups of five or more digits or alphanumerics are displayed and no natural organization exists, are the characters grouped in blocks of three to four characters each?	☐	☐	☐	☐
20. Are groups separated by a minimum of one blank character?	☐	☐	☐	☐
21. If the data contains a naturally occurring order, is that order reflected in the organization of the field?	☐	☐	☐	☐
22. Is identical data displayed in consistent, standardized manner irrespective of the module or origin?	☐	☐	☐	☐
23. If there is a case of double meanings, is the intended meaning specified?	☐	☐	☐	☐
24. When alphanumeric data is presented in tabular form, is it left justified?	☐	☐	☐	☐
25. When numeric data is presented in tabular form, is it right justified by decimal point?	☐	☐	☐	☐
26. Are lists vertically aligned?	☐	☐	☐	☐
27. Are lists left justified?	☐	☐	☐	☐
28. Are subclassifications indented?	☐	☐	☐	☐
29. Are tabular data displays used to present row-column data which is significant in itself?	☐	☐	☐	☐
30. Are graphics used to facilitate scanning or comparing numeric data?	☐	☐	☐	☐
31. Where appropriate, are line drawings used to supplement textual explanations?	☐	☐	☐	☐
32. Is tabular data displayed in a left to right, top to bottom array?	☐	☐	☐	☐
33. Is all the necessary data to support a user activity or sequence of activities grouped together?	☐	☐	☐	☐
34. Is the use of hyphenation minimized?	☐	☐	☐	☐
35. Are periods placed:				
a. At the end of a sentence?	☐	☐	☐	☐
b. After item selection number?	☐	☐	☐	☐
c. Where necessary for clarification?	☐	☐	☐	☐
36. Do frequently appearing commands and subcommands appear in the same place on the screen?	☐	☐	☐	☐
37. Are alphanumeric series as short as possible?	☐	☐	☐	☐
38. When developing alphabetic acronyms, are they pronounceable, and do they relate to the objects which they represent?	☐	☐	☐	☐
39. Are documents designed so that when copying data there is a minimum distance between the copying and the source?	☐	☐	☐	☐

	Yes	Not applicable	Not known *	no *
(Data presentation--cont'd)				
40. Are numbers and letters separated in the sequence since mixed alphanumeric acronyms are associated with more errors?	☐	☐	☐	☐
SIGNIFICANT DIGITS				
41. Does the system produce only numbers justified by the computational accuracy of its number handling procedures and the basic data?	☐	☐	☐	☐
42. Does the system round the output to the last significant digit?	☐	☐	☐	☐
CURSOR				
43. Does the system use a box or block type of cursor with an optional blinking capability?	☐	☐	☐	☐
44. Is the cursor blink rate three to five flashes per second?	☐	☐	☐	☐
45. Is the cursor easy to locate at random positions on the display?	☐	☐	☐	☐
46. Is the cursor easy to track as it is moved through the display?	☐	☐	☐	☐
47. Is the text free from visual interference by the cursor?	☐	☐	☐	☐
POSITIONING CURSOR				
48. Is the cursor positioned at the first character position of the first input field at the appearance of each frame?	☐	☐	☐	☐
49. As each input field is completed, does the cursor automatically go to the first character position of the next field?	☐	☐	☐	☐
50. Are formats organized to minimize user positioning movements of the cursor?	☐	☐	☐	☐
FIXED LENGTH ENTRIES				
51. Is a fixed length word or collection of characters indicated on the screen by underscores?	☐	☐	☐	☐
USER'S STATUS				
52. Is information detailing the user's status (file or mode) displayed?	☐	☐	☐	☐
HISTORICAL FILE				
53. Is an "historical" file of user actions available?	☐	☐	☐	☐
DISPLAY LEVELS				
54. If the system has multiple display levels, does the system: a. Minimize the number of levels required?	☐	☐	☐	☐
b . Provide priority access to the more critical display levels?	☐	☐	☐	☐

	Yes	Not applicable	Not known *	no *
(Display levels--Cont'd)				
c . Provide the user with information about the current position within the sequence of levels?	☐	☐	☐	☐
d . Insure similarity, wherever possible, between display formats at each level?	☐	☐	☐	☐
e . Supply all data relevant to making an entry on one display frame?	☐	☐	☐	☐
CODING				
55. Is coding used to:				
a. Differentiate between items of information?	☐	☐	☐	☐
b. Call the user's attention to changes in the state of the system?	☐	☐	☐	☐
56. Is flash coding used to call the user's attention to mission critical events only?	☐	☐	☐	☐
57. Is the flash rate between three and five flashes per second?	☐	☐	☐	☐
58. Are there equal on and off times?	☐	☐	☐	☐
59. Are event acknowledgement or flash suppression controls provided?	☐	☐	☐	☐
60. Is location coding used to reduce operator information search time?	☐	☐	☐	☐
61 Is symbol coding used to enhance information transfer?	☐	☐	☐	☐
62. Are the symbols:				
a. Analogs of the event or system element they represent?	☐	☐	☐	☐
b. Familiar to the users?	☐	☐	☐	☐
63. Where size difference between symbols is used:				
a . Is the larger at least 1.5 times the height of the smaller?	☐	☐	☐	☐
b. Is there a maximum of three size levels?	☐	☐	☐	☐
64. Is the information on the display only that which is necessary?	☐	☐	☐	☐
65. Is the information density held to a minimum on displays used for critical task sequences?	☐	☐	☐	☐
66. Is a minimum of one character space left blank vertically above and below critical information?	☐	☐	☐	☐
67. Is a minimim of two character spaces left blank horizontally before and after critical information?	☐	☐	☐	☐
68. Are certain areas of the display designated for certain types of information?	☐	☐	☐	☐
69. Are users able to temporarily or permanently eliminate irrelevant items from the display?	☐	☐	☐	☐

(Coding--cont'd)

	Yes	Not applicable	Not known *	no *
70. Does the system avoid breaking up the screen into many small windows or viewpoints?	☐	☐	☐	☐
71. Are the users able to see the entire page on which they are working?	☐	☐	☐	☐
72. For items or data that cover more than one page:				
a. Are those that are continued on another page numbered relative to the initial page(s)?	☐	☐	☐	☐
b. Is there a message indicating the data is on several pages?	☐	☐	☐	☐
73. Does the system contain a scroll or windowing function?	☐	☐	☐	☐
74. If the system does not offer windowing or scrolling, does it offer page scrolling or paging?	☐	☐	☐	☐
75. When scrolling, are the present and maximum locations displayed on the viewable portion?	☐	☐	☐	☐
76. Are frames designed so that the user can use one entry device as long as possible before switching to another?	☐	☐	☐	☐
77. Is running text displayed in both upper and lower case font?	☐	☐	☐	☐
78. When a new format, procedure, or command is defined that replaces an old one, is the user trapped to a brief description of the new one whenever the old one is typed?	☐	☐	☐	☐
79. Is the status of the system displayed to the user?	☐	☐	☐	☐
80. Does the system signal receipt of an entry immediately?	☐	☐	☐	☐
81. Does the system periodically (i.e., every 30 seconds) inform the user what the computer is doing while the user is waiting for a response?	☐	☐	☐	☐
82. Is the information necessary for the user to select, or to enter a specific control action, available on the screen when selection of that control action is available?	☐	☐	☐	☐
83. Are only the viable alternatives among the control actions displayed at the time of selection?	☐	☐	☐	☐
84. Is the current value of any parameter with which the user is interacting displayed?	☐	☐	☐	☐
85. Do the values displayed mislead the user with regard to:				
a. Nomenclature?	☐	☐	☐	☐
b. Units of measure?	☐	☐	☐	☐
c. Sequence of task steps?	☐	☐	☐	☐
d. Time phasing?	☐	☐	☐	☐

CONTROL INPUT DATA DISPLAY

86. Is the location and presence of control input data entered by the user clearly and appropriately indicated?	☐	☐	☐	☐

	Yes	Not applicable	Not known *	no *
(Control input data display--Cont'd)				
87. If the user is prompted by the system for a parameter with a predefined default, is the default shown?	☐	☐	☐	☐
STORAGE				
88. Are the users able to leave the system and store their work so that upon re-entry at a later date they can resume where they left off?	☐	☐	☐	☐
89. Are the users able to maintain files or libraries of their own subroutines, programs, defaults, and language equivalents?	☐	☐	☐	☐
90. Is the user able to combine commands to make a new command?	☐	☐	☐	☐
RESPONSE TIMES				
91. Does the system have a backup memory which stores all data disregarding changes or deletions for 72 hours?	☐	☐	☐	☐
92. Is the response time for system activation 2 seconds or less?	☐	☐	☐	☐
93. Is the response time from a request to contact another system 5 seconds or less?	☐	☐	☐	☐
94. Is the response time for a control activation such as appearance of a printed character after a key is depressed 0.1 seconds or less?	☐	☐	☐	☐
95. Is feedback that an ID card or number has been inserted correctly 0.5 seconds or less?	☐	☐	☐	☐
96. Is feedback that the ID number is correct in length or format 0.5 seconds or less?	☐	☐	☐	☐
97. Is a simple request or command implemented in 2 seconds or less?	☐	☐	☐	☐
98. Is a complex command either implemented or is feedback sent concerning implementation in 5 seconds or less?	☐	☐	☐	☐
99. If processing will take more than 15 seconds is an acoustic signal provided when the terminal is ready for the next command?	☐	☐	☐	☐
100. Is error feedback given within 2.0 seconds?	☐	☐	☐	☐
101. Are commands to interrupt automatic processes acknowledged within 2 seconds?	☐	☐	☐	☐
102. After requesting to interrupt an automatic process, are users able to execute new commands within 5.0 seconds?	☐	☐	☐	☐
103. For response times of 0-2 seconds, is the maximum variablity ± 5%?	☐	☐	☐	☐
104. For response to times of 5 seconds, is the maximum variability ± 10%?	☐	☐	☐	☐
105. For response times greater than 5 seconds, is the maximum variability ± 15%?	☐	☐	☐	☐

	Yes	Not applicable	Not known *	no *
PRINTED OUTPUT				
106. Is the user able to obtain a paper copy of the exact contents of the display?	☐	☐	☐	☐
107. If the printer output is printed away from the user, is a print conformation or denial message displayed?	☐	☐	☐	☐
108. Is the system designed so that the contents of the screen is not changed as a result of the print operation?	☐	☐	☐	☐
CONTROL FUNCTIONS				
109. Does the system dialogue prompt the user with next steps, or alternatives rather than just dead ending?	☐	☐	☐	☐
110. Is the user able to transfer control of different modes to another user?	☐	☐	☐	☐
111. Does the interactive system allow a specific time between the last keyboard action and automatic logout?	☐	☐	☐	☐
112. Is the user provided adequate information for making decisions?	☐	☐	☐	☐
113. Does the system give the user an indication of:				
a. How much time has been used?	☐	☐	☐	☐
b. How much money has been spent?	☐	☐	☐	☐
c. How much time is left in the account?	☐	☐	☐	☐
d. How much money is left in the account?	☐	☐	☐	☐
114. Are mechanical overlays avoided?	☐	☐	☐	☐
115. Are auditory signals used to alert and direct the user's attention to the appropriate visual display?	☐	☐	☐	☐
116. Is the intensity, duration, and source location of the signal compatible with the acoustical environment:				
a. Of the user?	☐	☐	☐	☐
b. Of other personnel in the signal area?	☐	☐	☐	☐
117. Is the system designed so that auditory signals used in conjunction with visual displays can not be falsely sounded for system failure or user response errors?	☐	☐	☐	☐
118. Can auditory signals be turned off at the discretion of the user?	☐	☐	☐	☐

* Answers in these two columns require some action to obtain information or justify departing from the guidelines.

System Designer
Signature: _____ Date: _____

Approved by: _____ Date: _____

User acceptance: _____ Date: _____

CHAPTER 4
LANGUAGE CONSIDERATIONS

The purposes of this chapter are to:

- ***Provide a list of guideline principles necessary for improving communication between the user and the computer. When a user can easily operate a terminal, efficiency and accuracy are improved.***
- ***Develop language standards that will aid in reducing operator error and decreasing data entry time.***

GENERAL

One of the major tasks facing users is learning how to communicate with the computer. The major problems with most languages occur when a person is learning to use them, and when a person tries to use something in the language that the individual has not used for some period of time. A logical and consistent language speeds learning, aids retention, and reduces language errors. The closer the language is to normal usage, the more effective it is likely to be. The guidelines below are intended to help the designer achieve effective language continuity.

COMMON WORDS

Appendix C contains a list of suggested command words by proposed standard keywords, functions considered (together with some keywords associated with each function, and the keyword selected), and glossary of keywords linking the function intended with the standard keyword suggested.[1]

- The length of individual input words (command, keywords) should not exceed 5-7 characters.[2]

INDEXES

Special indexes would allow operating information to be obtained on-line

- On-line indexes should be provided for such things as commands, inquiries, data bases, etc.[1]

LANGUAGE TONE

- Labels and messages should be distinct, meaningful, and easily discriminated.
- No attempts at humor or punishment should be made in messages from the system.
- The user should be made to feel in control of the system. Avoid references to the system as a person.[2] For example,

Poor: You entered the wrong number. Try again, Item number not computable.

Acceptable: Please check item number. Item numbers must have 11 digits.

User's Frame of Reference

- Terminology should be that of the functional user rather than that of the designer.
- Commands should be logically related to what the user thinks is being done for him. The user always should be able to request help for determining what commands are permitted.
- The interactive version of a language should be as identical as possible to the non-interactive version of the existing language.[4,5]

Language Pilot Testing

A sample from the user population should review the proposed manuals, forms, prompts, and menus and indicate words and phrases that are not understood or that are confusing.[5]

Consistent Nomenclature

The nomenclature should be the same for similar or identical functions across components, tasks, roles, and systems for command names, subcommand names, and parameters. For example, it is improper to use edit, modify, and update when only one operation is actually being done.

Language Consistency

The terminology should be consistant. For example, if U means UP then users would expect D to mean DOWN not DELETE.[5]

Memorization

The requirement to learn mnemonics, codes, special, or long sequences, and special instructions should be minimized.[6]

A Meaningful Code

When numerical codes of abstract design are used, it is difficult for humans to learn meanings. Codes can be designed to aid human memory.[2] For example:

Poor:	*Acceptable:*
7964388	Tnk 437
ACD3528	M60 3250
756A427	M155 428

Input Prompt

An input prompt should clearly indicate to the user that the computer is waiting for a response or a command. A special character or a character never used alone may serve for this purpose. Common prompts include "?", ":", and "@". Different prompts can be used to indicate what mode or subsystem the user is working in.

Messages

When a message appears on the screen, both the content of the message and the action required by the user should be explicit.[2] For example:

Poor:	*Acceptable:*
Display device number	Please key in display device number and press ENTER

Symbology

- Symbols should be standardized for meaning when used to display information.
- Symbols should be standardized within the system and among systems having similar operational requirements.[6]

If logical operants are commonly used to manipulate files or data such as, "and", "or", and "not", provide continuous presentation of venn diagrams on the screen to illustrate the meaning of the operators. Many errors are associated with these operators necessitating this visual representation of their meaning.[7]

Abbreviations and Acronyms

Generally, information should be displayed in plain concise text. Where space does not permit plain text, approved abbreviations or acronyms and display codes should be used if possible. Abbreviations and acronyms should be from MIL-STD-12, MIL-STD-411, and MIL-STD-783. New acronyms, if required, should be developed using the rules of abbreviation in MIL-STD-12. A list of approved abbreviations should be available to the user.

Careful consideration should be given to the use of abbreviations for output not previously given as input. Abbreviations should be used only if significantly shorter (more than two letters) than the complete word and when most users regularly use abbreviations. Abbreviations should be unique.[2,6]

STANDARDIZED FIELDS

The following standardized fields should be used:

- For telephone number use: (area code) basic exchange, stations extensions, e.g.; (409) 278-3654/3655/5422.
- For time, use: HH:MM:SS, HH:MM, HH:SS(.S) 12:08:42
- For date, use: DD, three-position alphabetic for month, YY — 14 Nov 81. (The use of the three letters eliminates confusion as to what indicates days and what indicates months.)[6]

DATA LABELS

Fields should be identified or labeled so that the user can recognize the data category.[2] For example:

Poor:	*Acceptable:*
619-721-2345	Telephone (619) 721-2345
12/12/78	Date: 12/Dec/78

LABELING LISTS

Numbers should be used when listing items to be selected. Alphabetic characters may take a relatively long time for non-typists to locate. Alphabetic characters, however, may be used in descriptions.

Menu item numbers should begin with one, not zero. Numbering should start with one when it applies to counting; zero when applied to measurement.[2]

INDIVIDUALIZED LANGUAGE

A means should be provided so that users can create their own input commands (for their personal use) by giving a unique name to sequence of commands that they have defined.

The user should not be allowed to make language changes that will affect other users in any way.[2]

USER SYNONYMS

If a user is using a synonym for a system command name, the system should use that same synonym in messages, prompts, etc. to the user.[2]

HYPHENATION

The use of hyphenation should be minimized. Text is more readable if the entire word is on one line.

On composition modes, automatic carriage return should be considered.[2]

PUNCTUATION

Unnecessary punctuation should be avoided. Abbreviations, mnemonics, and acronyms should not include punctuation.[2] For example:

Poor:	***Acceptable:***
U.S.A.	USA

BLANKS

The user should not have to distinguish between single and multiple blanks, or use commands whose meaning depends on single or multiple blanks preceeding or following the commands.[8]

CHAPTER 4. REFERENCES

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CHAPTER 4. CHECKLIST

	Yes	Not applicable	Not known	no
LANGUAGE				
1. Is the language:				
a. Logical?	☐	☐	☐	☐
b. Consistant?	☐	☐	☐	☐
2. Do the commands conform to those in Appendix B?	☐	☐	☐	☐
3. Are the command words congruent; i.e., if U means up, does D stand for down?	☐	☐	☐	☐
INDEXES				
4. Are on-line indexes provided for:				
a. Commands?	☐	☐	☐	☐
b. Inquiries?	☐	☐	☐	☐
c. Data bases, etc?	☐	☐	☐	☐
5. Do the indexes allow operating information to be obtained on-line?	☐	☐	☐	☐
6. Are the labels and messages:				
a. Distinct?	☐	☐	☐	☐
b. Meaningful?	☐	☐	☐	☐
7. Are the messages free from humor or punishment?	☐	☐	☐	☐
8. Is the terminology that of the functional user rather than that of the designer?	☐	☐	☐	☐
9. Are the commands logically related to the user's conception of what is being done for him?	☐	☐	☐	☐
10. Is the user able to request help at any time for determining what commands are permitted?	☐	☐	☐	☐
11. Is the interactive version of the language as identical as possible to the noninteractive version of the existing language?	☐	☐	☐	☐
12. Was the language reviewed by a sample from the user population?	☐	☐	☐	☐
13. Is the nonemclature the same for similar or identical functions across all modes?	☐	☐	☐	☐
MEMORIZATION				
14. Is memorization of codes, sequences, etc., minimized?	☐	☐	☐	☐
15. Are the codes designed to aid human memory?	☐	☐	☐	☐
16. Does the system make clear to the user not only the context of the message, but also what is required?	☐	☐	☐	☐
17. Is there a clear indication of when the computer is waiting for a response or command from the user?	☐	☐	☐	☐

	Yes	Not applicable	Not known	no
SYMBOLOGY				
18. Are the symbols standardized:				
a. Within the system?	☐	☐	☐	☐
b. Among systems having similar operations?	☐	☐	☐	☐
19. If logical operators (such as *and*, *or*, and *not*) are used to manipulate files or data, are venn diagrams, illustrating the meaning of these terms continuously displayed to reduce errors?	☐	☐	☐	☐
20. Is the information displayed in plain, concise text?	☐	☐	☐	☐
21. If space does not permit plain text, are approved abbreviations, acronyms, or display codes used?	☐	☐	☐	☐
22. Are abbreviations used for output only when they were given as input?	☐	☐	☐	☐
23. Are abbreviations used only if they are significantly shorter than the complete word?	☐	☐	☐	☐
24. Is each abbreviation unique?	☐	☐	☐	☐
25. Are standardized fields used for:				
a. The time?	☐	☐	☐	☐
b. The date?	☐	☐	☐	☐
c. Telephone numbers?	☐	☐	☐	☐
26. Is the standard displayed when the user is inputing this information?	☐	☐	☐	☐
27. Are the fields identified so that the user can recognize the data category?	☐	☐	☐	☐
28. Are numbers used when listing selectable items?	☐	☐	☐	☐
29. Are alphabetic characters used in prose or text?	☐	☐	☐	☐
30. Do the numbered menu items start with one?	☐	☐	☐	☐
31. Is there a system provision allowing individuals to create their own commands by giving a unique name to a fixed sequence of commands?	☐	☐	☐	☐
32. If so, is the system designed so that user changes will not affect other users in any way?	☐	☐	☐	☐
33. If the user is using a synonym for a system command name, does the system use that same synonym when interacting with the user?	☐	☐	☐	☐
34. Is the use of hyphens minimized?	☐	☐	☐	☐
35. Is automatic carriage return used in composition modes?	☐	☐	☐	☐

	Yes	Not applicable	Not known *	no *
36. Is unnecessary punctuation avoided?	☐	☐	☐	☐
37. Is the information displayed so that the user *does not* have to distinguish between single and double blank spaces?	☐	☐	☐	☐

*Answers in these two columns require some action to obtain information or justify departing from the guidelines.

System Designer
Signature: _____ Date: _____

Approved by: _____ Date: _____

User acceptance: _____ Date: _____

CHAPTER 5
WORKING IN THE FILE

The purpose of this chapter is to:

- ***Provide a list of guidelines for facilitating common user tasks, such as data entry, error correction, and editing.***

INTRODUCTION

In this section, various ways to make common tasks easier for the user are discussed.

Many obstacles can impede productivity. This unit defines some of the characteristics of a "friendly" system for the person entering data, manipulating or updating files or correcting errors. As mentioned earlier, users' attitudes are affected by the ease with which they can accomplish their tasks. Users not only avoid cumbersome systems, but often take active measures to sabotage such systems.

Systems in which work is accomplished with little effort should increase productivity, and produce positive user attitudes

KEYBOARD ENTRY

- Data being entered through a keyboard should be displayed on the screen as keyed except for passwords or other security measures.[1]
- If a user cannot log onto a system because of overloading, insufficient funds, etc., a message should be sent explaining why, and what should be done; e.g., "see accounting department for funding".[2]

LOGGING-ON

- When a user dials up or connects to the system, the LOGON frame should appear as soon as possible on the terminal with no additional user involvement. If this is not possible, as soon as the user keys ENTER, the system should send the "LOGON" frame, *never* an error message. After completing the sign-on process, the user should be able to start productive work immediately.[2]

REDUNDANT KEYING

Keying redundant data or data already known by the system should not be required of the user except for special conditions such as security.

- The software should minimize the need to enter information that is already available to the program. For example, do not ask the user to enter both the customer name and account number if one specifies the other.
- A glossary should link all of the information of a record at the time of initial entry so that keying any of the unique elements will retrieve the whole record.[1,2]

PROVIDE INFORMATION

- The user should not have to search through reference material to interpret system messages. However, the system may refer the user to an internal or external source for additional information.[2]

TECHNICAL KNOWLEDGE

- Knowledge of the internal retrieval and storage mechanisms and other technical aspects of the system should not be required of the user.

ENTER

Commands, selection of menu options, data input and error correction should require an explicit ENTER action, and should not be made as a side effect of some other action.

CRITICAL ACTIONS

Critical actions are those that can cause data to be lost, or that require lengthy recovery procedures.

- It should never be possible to perform a critical action with a single keystroke. A double check (verification) will prevent accidental destruction of, or changes to, the file.[2] For example: the computer asks the user to *verify* a specific proposed critical action.

Poor: (PLEASE VERIFY) DELETE

Acceptable: PLEASE VERIFY: DELETE XYZ FILE

LOGOFF

If there are pending actions and the user requests a logoff, the system should inform the user that these actions will be lost.

SYSTEM RESPONSES

System users need to know both that the system is functioning and that their commands are received. Commands should be acknowledged within one second.

Correct user input should result in immediate changes to the displayed elements; if it does not affect the display, or if response time exceeds 1 second, acknowledgement is required.

- Periodic feedback should be provided the user when the system is in a standby mode of operation.
- Provisions should be built into the system to inform the user why input was rejected and the corrective actions to take.
- User's need feedback both on the outcome of completed processes, and actions to be taken when the system aborts.
- When a displayed message (or any data) is chosen as an option or input to the system, the subject item should be highlighted to indicate acceptance by the system.
- Error messages should contain an identification code that refers the user to off-line documentation.
- The system should include an easy way for the user to return to the main dialogue after requesting help, asking for information or correcting an error.

SCREEN CORRESPONDS TO FORM SEQUENCE

- Forms that are used for inputting, updating, or correcting data should correspond to screen display and vice versa.[2]

MINIMIZE TYPING

- User typing should be kept to a minimum. The probability of error increases as the size of the entry increases. Many users may not be trained typists which compounds this problem. This applies both to data entry and control inputs.[3]

TEMPORARY OMISSION OF DATA

- When entry of a required data item is deferred, the user should enter a special symbol in the field to indicate that the item has been temporarily omitted rather than ignored. Before the data is transferred to storage or when the data is subsequently accessed, the user should be reminded that some data is missing.[4]

FIXED FUNCTION KEYS

- Fixed function (dedicated) keys should be considered for time-critical, error-critical, or frequently used control inputs.[1]

ENTRY STACKING

- The system should provide for entry stacking (the use of multiple commands separated by a slash). This allows the transmission of a thought sequence.[2]

DELETE KEY

- A single control character should delete the last character. The delete operation should be interactive, allowing the user to delete successively the last characters typed. It is recommended that this key be placed next to the "Q" key. A separate function should be provided to delete the entire last line. This would provide a means for quickly correcting errors. One possibility is to have the delete key erase the entire line when the shift key is also depressed.

INSERTING

When inserting words or phrases (e.g., editing), items to be inserted should be displayed as the final copy will appear. Another option is to collect and display the items to be inserted in a buffer area of the screen.[1]

DEFAULT OPTIONS

If many inputs have the same components, the user should be provided with a default option. For example, addresses having the same ZIP code number, the ZIP should be entered only once. The system should then duplicate the ZIP codes automatically. The default will save time by requiring less key strokes. It is recommended that the user be allowed to change or initiate defaults for his own use.[5]

COLUMNAR FORMS COMPLETION

When one or more columns may go unchanged from line to line, the system should be allowed to use the previous line as a default-automatic ditto. A fixed function key is recommended for this function.[5] For example:

DODMIC	AMMO	30 cal	case	40
DODMIC	***AMMO***	155 cal	***case***	35
DODMIC	***AMMO***	***155 cal***	***case***	11

FIELD SEPARATORS

- Multiple data items should be entered without the need for special separators or delimiters if possible. If a field delimiter is needed, a slash (/) is recommended.[4]

INVALID COMMANDS

If the user selects a function key that is invalid at any point in the transaction, no action should result except display of an advisory message indicating what functions or options are appropriate.

STEP REPLACEMENT

If steps are .13, .14 and additional steps are needed between .13 and .14 these steps can be inserted without renumbering the old steps, (i.e., .13, .131, .132, .14).[2]

LEADING ZEROES

- Leading zeroes should not be entered if they have no meaning.[2]

UNRECOGNIZED COMMAND

- If the user presents a command not recognized by the system, the system should indicate its nonacceptance of the command to the user and provide a list of applicable commands if these can be determined.[2]

HIGHLIGHTING

Highlighting can be used either to attract the user's attention or to provide feedback. If a user is using a particular data item, highlighting that item on the display lets the user readily see which item is being worked on. The criteria for ranking or selecting highlight types are: they should not interfere with the readability of the material, they should be easily recognizable, they should be commonly used. A highlighting technique similar to that used on the CRT should be considered for those cases where highlighting will also be used on a printout.

Boxing (enclosing the item with lines) is available and is the primary choice for printouts and CRTs. Reverse display is not available on the printer but is somewhat similar to boxing and is very recognizable on CRTs.

Other highlighting techniques include: position displacement (the primary choice for vertically oriented lists of information); blinking, used only for alarms, (that is, when gaining the attention of the operator outweighs the irritation and reduced legibility associated with blinking); color, (must be carefully considered because of the inability of some people to differentiate certain colors, and avoided if some screens do not have color capability).

If additional coding is needed, size, orientation, and style of characters can be used.

Highlighting a subset of items to be selected can speed selection time and possibly reduce errors. The highlighting for an item to be chosen should differ from that highlighting used as feedback when an item is selected.[2]

OPTIONS SELECTED

To provide feedback, the options selected by the user should be highlighted. Selecting the option again should cancel its use, remove the highlight, and redisplay options as originally presented.[2]

USER HIGHLIGHTING

Highlighting the line of data that the cursor is on at the user option can improve performance. This is especially true when dealing with certain kinds of data in which it is difficult to keep track of the line on which one is working.[6] For example, the lines on the illustration below (fig 5-1) demonstrate user highlighting.

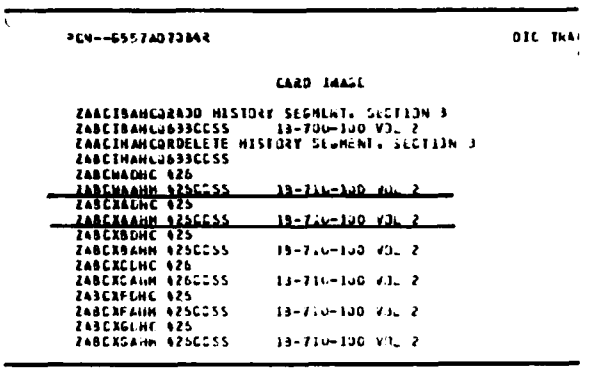

Figure 5-1. Highlighting.

INTERACTION

If two or more users must have simultaneous access to the computer program or data processing, results from an operation by one person should not interfere with the operations of the other person.[1]

EXPLICIT EXIT

The user should be allowed to exit a process only by explicit command. This helps prevent the user from accidently leaving the desired mode.[2]

EDIT TRAIL

The use of several coding styles can be used where a history of changes to a text are required. The

original version of the article with all changes and a key indicating the changed data should be provided.[7]

SPLIT AND DUAL SCREENS

Split and dual screens are recommended for comparing or merging two texts, for inspecting a given set of typographic and layout commands, or while listing and editing the commands themselves.

FEEDBACK/PROMPTING/ERRORS

Feedback

Feedback should be provided to the user to indicate how the system is functioning. Feedback should conform to the following guidelines:

- The system should acknowledge receipt of a command within 1 second.
- Where possible, feedback responses to correct user input should consist of direct changes of those displayed elements. An acknowledgement message should be used when the command does not effect the display or when feedback response time must exceed 1 second.
- When a displayed message or data is selected by the user as an option or input to the system, the subject item should be highlighted to indicate acknowledgement by the system
- When the system requires the user to standby, periodic feedback should be provided to indicate normal system operation.
- When a process is completed or aborted by the system, the user should be informed about the outcome of the process and any requirements for subsequent actions.
- If the system rejects a user's input, feedback should indicate the reason for rejection and the required corrective action. It should be self-explanatory
- Error messages should contain an identification code which refers the user to off-line documentation
- After requesting information or help, or correcting an error, the user should be provided with an easy way to return to the main dialogue.[1,2]

Prompting/Structuring

The system should contain prompting and structuring features designed to request additional or corrected information from the user or to provide orientation to the user throughout an interactive session or when an error is detected. Prompting and structuring should conform to the following guidelines:

- The system should display the operating mode and the name of the active file displayed.
- The system should permit correction of individual errors without requiring re-entry of correctly answered data.
- Before processing any user requests that would result in extensive, final, and permanent changes to existing data, the system should require user verification.
- Work activities should be programed to require the user to issue an explicit command in order to exit that activity.
- Sign-on processes should be designed to require minimum input from the user consistent with requirements prohibiting illegal entry.
- The level of prompting should be controllable by the user.
- Prompting messages should appear at a standard location on the screen. For example, at the beginning of the next line to be typed.
- The system should prompt for all required parameters. The prompt should tell the user exactly what is required, giving the user the options if there are six or fewer. For an option with many choices, an example of the type of entry that is required should be presented.
- To minimize response time, options should be ordered by the frequency of use, alphabetically, or in some other consistent fashion.[2]

Errors, Omissions, and Prompting

Error correction. There is evidence that approximately 80% of all keying errors are conscious. Where operators are required to make entries into the system, an easy means for correcting erroneous entries should be provided.[1,8]

Error message content. When a message is sent to alert the user to an internally-detected error condition, the message should explicitly provide as much diagnostic information and remedial direction as can be inferred reliably from the error condition. Such information and direction should reflect the user's point of view of what is needed for recovery. When it is not possible to give a clear-cut deduction, an "educated guess" may be helpful.[1]

Error recovery and process change. The users should be able to stop their control process at any point in a sequence as a result of indicated error or as an option. The user should be able to return easily to

previous levels in multi-step processes in order to nullify an error or to make a desired change. The ability to undo or redo the last one, two, or three commands should be considered.[1]

Changing errors. The user should not have to re-enter an entire line solely because of the misspelling or omission of one word (even a command word). An appropriate mechanism such as an auto cursor can be used to change data detected as incorrect or to insert needed data.

Rejected input. The error message should be displayed with the rejected input and that portion in error highlighted so that the user has the option to correct it or type new input. When there is lengthy input with a minor typing mistake, this saves time and avoids frustration.[9]

Error message delay. The user should be provided with an error message as soon as possible.[10]

Message content. All error messages should indicate:

Where the error occurred.

The nature of the error, and

One or more ways to recover from the error or where to find out how to recover.[10]

Multiple errors. The terminal software should supply the number of errors detected if there is more than one error. All fields found in error should be indicated until they are modified. If an error occurs when making a correction, the new error is presented next.[10]

Variable length error messages. The user should be able to select the type of error message sent by the system. New or infrequent users probably will need detailed messages including options available or an example of a correct message; while an experienced user may desire a very brief error message. In most cases two levels of error messages should be sufficient.[2]

Command abort. A user should be able to alter a line of input during and after entry. That is, a user should be able to tell the computer to stop working on the last command or the present command.[2]

Imbedded error. If an error is discovered in a string of user entries, the computer should process the input to the point of error, and then send the appropriate error message.[2]

Non-threatening error message. Error messages should be understandable and non-threatening. Avoid condemning messages.[2] For example: Date entered as 4/8/82

Poor	***Acceptable***
ERROR — 49-ILLEGAL FORMAT	Months require the first three letters as an alphabetic abbreviation; e.g., Jan, Feb

User input errors. Should be minimized through internal software validation checks of an item, sequence of entry, completeness of the entry, etc. For example, if the field position can be only alphabetic, software should detect numerics. The error message should include a statement such as "Alphabetic characters required". For numbers, the error statement could be "number required" or "numbers between x and y required".[10]

System status telephone line. It is recommended that a telephone number be provided which the user can call for accurate information concerning problems, questions, or the status of the system.[6]

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CHAPTER 5 CHECKLIST

	Yes	Not applicable	Not known *	no *
SYMBOLOGY				
1. Is the data that is entered through the keyboard displayed as keyed on the screen?	☐	☐	☐	☐
2. Are there provisions for not showing passwords or other security measures on the screen?	☐	☐	☐	☐
3. If users cannot log into the system, are they:				
a. Notified why?	☐	☐	☐	☐
b. What action to take?	☐	☐	☐	☐
4. Does the LOG-ON frame appear as soon as the user connects to the system?	☐	☐	☐	☐
5. Does the software minimize the requirement for a user to enter information that is already available to the program?	☐	☐	☐	☐
6. After sign-on, is the user able to start productive work immediately?	☐	☐	☐	☐
7. Do data entry, error correction, selection of menu items, and commands require an explicit user action?	☐	☐	☐	☐
8. Is the system designed so that the user does not have to be familiar with the internal retrieval and storage mechanisms?	☐	☐	☐	☐
9. Does the system refer the user to other sources for additional explanatory information?	☐	☐	☐	☐
10. Does the system ask the user to verify critical actions?	☐	☐	☐	☐
11. When the user signals for log-off, are pending transactions checked to see if this would cause data loss?	☐	☐	☐	☐
12. Do forms correspond to the screen display or vice versa?	☐	☐	☐	☐
13. Can the user indicate that required data has been temporarily omitted?	☐	☐	☐	☐
14. Is user typing kept to a minimum?	☐	☐	☐	☐
15. Are fixed function (dedicated keys) used for:				
a. Time critical inputs?	☐	☐	☐	☐
b. Error critical inputs?	☐	☐	☐	☐
c. Frequently used control inputs?	☐	☐	☐	☐
16. Does the system provide for command stacking?	☐	☐	☐	☐
17. DELETE key:				
a. Does it allow for successive deletion of characters?	☐	☐	☐	☐
b. Is it placed next to the letter Q?	☐	☐	☐	☐
18. Is a separate mechanism provided for deleting the entire last line?	☐	☐	☐	☐
19. When editing, does the user have the option to have the insertion displayed:				
a . Where it actually will appear?	☐	☐	☐	☐

(Symbology--cont'd)	Yes	Not applicable	Not known *	no *
b. In a buffer area of the screen?	☐	☐	☐	☐
20. If many inputs have components which are the same, is a ditto or a default option provided to the user?	☐	☐	☐	☐
21. Is the user able to change or initiate defaults for his own use?	☐	☐	☐	☐
22. With columns of data, does the system use the previous line as a default — automatic ditto?	☐	☐	☐	☐
23. Can additional steps be inserted without renumbering the old steps?	☐	☐	☐	☐
24. Are leading zeroes used only if they have meaning?	☐	☐	☐	☐
25. If the system does not recognize a command entered by the user, does the system:				
a. Indicate nonacceptance?	☐	☐	☐	☐
b. Provide a list of applicable commands?	☐	☐	☐	☐
26. Are multiple data items enterable without special separators or delimiters?	☐	☐	☐	☐
27. Is the item that the user is currently working on highlighted?	☐	☐	☐	☐
28. Are the highlighting methods used by the system designed so that they:				
a . Do not interfere with the readability of the material?	☐	☐	☐	☐
b. Are easily recognizable?	☐	☐	☐	☐
c . Are available for both the CRT and the printouts?	☐	☐	☐	☐
29. Does the user have the option of highlighting a line of data?	☐	☐	☐	☐
30. If color is used for highlighting, do ALL CRTs have color and can the colors be recognized by color blind operators?	☐	☐	☐	☐
31. If additional coding or highlighting is needed, is it provided for?	☐	☐	☐	☐
32. Is the highlighting used for each function unique?	☐	☐	☐	☐
33. Are the options selected by the user highlighted?	☐	☐	☐	☐
34. To cancel the highlighting is the option selected again?	☐	☐	☐	☐
35. Is the system designed so that simultaneous users do not interfere with each other's operation?	☐	☐	☐	☐
36. Does the system require an explicit command before the user can exit the system?	☐	☐	☐	☐
37. Is it possible to indicate the history of changes to a text where this is required?	☐	☐	☐	☐
38. Are split or dual screens provided for:				
a. Comparing or merging two texts?	☐	☐	☐	☐
b . Inspecting a given set of typographic and layout commands?	☐	☐	☐	☐

	Yes	Not applicable	Not known *	no *
(Symbology--cont'd)				
c. Listing and editing the commands?	☐	☐	☐	☐
39. Is feedback provided to indicate the status of system functioning?	☐	☐	☐	☐
40. Does the system acknowledge receipt of a command within one second?	☐	☐	☐	☐
41. Do feedback responses to correct user input consist of direct changes into those elements displayed?	☐	☐	☐	☐
42. Is an acknowledgement message used:				
a . Where the command does not effect the display?	☐	☐	☐	☐
b . Where feedback response time must exceed one second?	☐	☐	☐	☐
43. When a displayed message or datum is selected by the user as an option or input to the system, is it acknowledged by the system?	☐	☐	☐	☐
44. When the system is processing command(s), is periodic feedback provided to the operator?	☐	☐	☐	☐
45. If a process which has taken more than 15 seconds is completed by the system, is the user given an auditory indication of this?	☐	☐	☐	☐
46. If a process is aborted by the system, is the user prompted by requirements for subsequent user actions?	☐	☐	☐	☐
47. If the system rejects a user input, is the user provided with:				
a. The reason?	☐	☐	☐	☐
b. The required corrective action?	☐	☐	☐	☐
48. Does the system allow easy transitions between modes such as error correction, information requests, typing text, etc?	☐	☐	☐	☐
49. Does the system display:				
a. The operating mode?	☐	☐	☐	☐
b. The name of the file displayed?	☐	☐	☐	☐
50. Does the system permit correction of individual errors without requiring re-entry of correctly answered data?	☐	☐	☐	☐
51. Does the system require verification before processing changes which result in extensive, final, and permanent change to data?	☐	☐	☐	☐
52. Does the system require an explicit command for exiting from an activity?	☐	☐	☐	☐
53. Do sign-on processes require minimum input from the user?	☐	☐	☐	☐
54. Is the level of prompting controllable by the user?	☐	☐	☐	☐
55. Does the system prompt for all required parameters?	☐	☐	☐	☐

(Symbology -cont'd)

	Yes	Not applicable	Not known *	no *
56. Are all the options displayed for any one field wherever possible?	☐	☐	☐	☐
57. Are user options ordered:				
a. By frequency of user?	☐	☐	☐	☐
b. Alphabetically?	☐	☐	☐	☐
c. In some other consistent fashion?	☐	☐	☐	☐
58. Is an easy means of correcting errors provided?	☐	☐	☐	☐
59. Are the users able to stop their control process at any point in the sequence as a result of:				
a. An indicated error?	☐	☐	☐	☐
b. User option?	☐	☐	☐	☐
60. Is the user able to return easily to previous levels in multi-step processes in order to:				
a. Nullify an error?	☐	☐	☐	☐
b. Make a desired change?	☐	☐	☐	☐
61. Can the user cancel or re-enter already entered commands?	☐	☐	☐	☐
62. Is a means provided for correcting or inserting data?	☐	☐	☐	☐
63. In a message that has been rejected, is the portion in error highlighted?	☐	☐	☐	☐
64. Is the user provided with an error message as soon as possible?	☐	☐	☐	☐
65. Do error messages communicate:				
a. Where the error occurred?	☐	☐	☐	☐
b. The nature of the error?	☐	☐	☐	☐
c. How to recover from the error?	☐	☐	☐	☐
d. Where to find out how to recover from the error?	☐	☐	☐	☐
66. Are all fields found in error indicated until they are corrected?	☐	☐	☐	☐
67. If a new error is generated in the attempt to correct an error, is the new error presented next?	☐	☐	☐	☐
68. Does the system include at least two levels of error messages?	☐	☐	☐	☐
69. Are users able to alter a line of input:				
a. During entry?	☐	☐	☐	☐
b. After entry?	☐	☐	☐	☐
70. If an error is detected in a string of user entries, does the computer process the input to the point of error, and then generate an error message?	☐	☐	☐	☐

	Yes	Not applicable	Not known *	no *
NON-THREATENING ERROR MESSAGE				
71. Are error messages:				
a. Understandable?	☐	☐	☐	☐
b. Non-threatening?	☐	☐	☐	☐
72. Are user errors minimized by internal software checks?	☐	☐	☐	☐
73. Is the user provided a telephone number to call for *ACCURATE* system information?	☐	☐	☐	☐

* Answers in these two columns require some action to obtain information or justify departing from the guidelines.

System Designer
Signature: _____ Date: _____

Approved by: _____ Date: _____

User acceptance: _____ Date: _____

CHAPTER 6
FORMS, MANUALS, AND FICHE

The purposes of this chapter are to:

- ***Provide general principles in designing input source forms.***
- ***Provide a format for developing user manuals***
- ***Outline design considerations in using 'fiche'.***

INTRODUCTION

Forms, manuals, and fiche are seldom given adequate consideration in the design of a system. Bad forms contribute to many errors and decrease productivity.

Manuals require a continuing effort to keep them current with system changes. They are a source of information that is not available on-line to the user. Manuals frequently fail to meet user needs because the cost to produce and maintain them is a limiting factor.

Fiche has not been well accepted as a general rule. It has been frequently associated with visual problems; one study showed few users could work with fiche for more than 30 minutes without experiencing visual problems. Additionally, the mechanics of fiche usage in some systems have not been thought through. For many users, it has complicated rather than simplified their work.[1]

FORMS

Forms must be readable and easily understood. The sequence of data on forms should correspond to the sequence of data on the CRT, so that data can be transfered from the screen or the form with a minimum number of transpositions. Forms should be pilot tested where possible. Designers should consider the following points.[1]

Blank Spaces

Adequate space should be provided for answers. This space needs to be big enough to include all the information and located so that the user knows where to write. The bigger the gap between question and answer the greater the possibility of the error or confusion as to which question should be answered where.

Subdividing Spaces

Subdividing answer spaces slows the writer and decreases the legibility of the material. For example:

Poor:

/////////////////

Print last name first name

Acceptable:

_____ /

Print last name first name

Blocks

Where blocks are used they should be 0.28 in × 0.28 in (7 mm × 7 mm). Many forms have blocks 0.20 in × 0.20 in (5mm × 5mm) which are considered too small by many users.[1]

Unit of Measure

When a unit of measure is always associated with a particular entry field, the unit should be displayed as part of the fixed label.

MANUALS

Manuals need to be self-explanatory, accurate, and complete. They should contain summary pages at the beginning or at the first tab, and at a minimum, list all the commands, the entry or edit sequences, and the most common problems and their solutions. As can be seen in Table 6-1, there are many considerations in designing a manual.[1]

Table 6-1. Designing a manual.

Determine the function:

Will the manual serve as a reference or review source?

Will the manual be used for education and/or instruction?

Determine the Users:

Will the users be functionally or ADP oriented?

Will the use of the manual be independent of other documents?

Determine the format:

How are similar documents used? For example, should it be small enough to be placed at the CRT?

Table 6-1. A model for designing a manual--Continued.

Determining the format (continued):

Will referenced material be readily available?

How will the manual be distributed?

How will the manual be updated, revised, maintained?

Determine a review cycle:

Who will write the initial draft?

Who will review the initial draft?

Who will revise and re-review the draft?

Who will use the draft in a test mode?

Who will perform periodic evaluation?

Indexes

Manuals should have an extensive table of contents and an index to help users locate information.[1]

Examples.

Examples, including sequential pictures of a CRT screen and keyboard actions should be used.[1]

Headings

Using headings and subheadings can be a benefit to the reader. Headings appear to provide a context which assists understanding. Designers should avoid vertical arrangement of words since this style is less easily read.[2] For example:

Poor:	***Acceptable:***
M S C I E O L R D I V E T I S A C R E Y	MILITARY SERVICE CODES

Organize Natural Sequences

The instructions should be given in the order they are performed.[2] For example:

Poor: Before filling in the form, read the notes.

Acceptable: Read the notes, then fill in the form.

Double Questions

Questions should be limited to one idea at a time.[2] For example:

Poor: Is it oversize and/or overweight?

Acceptable: Is it oversize?
Is it overweight?

Simple Sentences

Short sentences are more easily understood than long ones. Easily understood sentences have only one clause, are active rather than passive, and are affirmative rather than negative.[2]

Avoid Choppiness

People find it easier to understand the meaning of closely interrelated ideas when they are expressed in the same sentence.[2] For example:

Poor: A separate procedure is provided to delete a whole line. Pressing both the DELETE key and the SHIFT key is required. When both are pushed the whole line is deleted.

Acceptable: Press both the DELETE key and the SHIFT key to delete a whole line.

Active Sentences

Active sentences are more easily understood than passive sentences. For example, "read the notes" is better than, "the notes should be read". Use the passive tense only when you intend to focus attention to the agent.[2]

Positive Connotations

Expressions such as "increase" or "more than" have positive connotations and are easier to understand than words with negative connotations such as "reduce" or "less than".[2]

Negatives

Sentences with negative elements are more difficult to understand than affirmative sentences. The affirmative alternative should be stated first.[2] For example:

Poor: Do not write in this box if you already receive a pension.

Acceptable: Leave this box blank if you already receive a pension.

Negatives should be used to increase emphasis; e.g., Do NOT use pencil.

Decision Trees

As an alternative to prose, consideration should be given to the use of decision trees. Like logic diagrams in flow charting, decision trees can be used to graphically guide inexperienced or infrequent users through an operation; e.g., if yes, go to paragraph 8, if no, go to paragraph 14, if uncertain, go to paragraph 2.[2]

Pictorials

The use of tables, illustrations, pictures, graphics, and examples is encouraged to aid understanding of ideas.

FICHE

Almost all users of fiche complain about visual problems if the fiche is viewed for longer than 30 minutes at one time. The following considerations can reduce the problems associated with fiche:

- Make quality checks to ensure the readability of fiche. Blurry fiche is very annoying.
- Generally, use a dark background with white letters.
- Most fiche machines require frequent cleaning to avoid distortion caused by smudge marks and dust.
- Readers/printers that do not use fans are preferable. Such models usually create less heat and do not blow it at the user. Fans may also cause vibrations.
- When selecting a fiche reader/printer, check for distortions on the edges of the screen.
- Check to see if the characters on the screen are large enough (0.156 in (3.96mm)) and whether other legibility guidelines are being followed.
- Determine if a hood or polarizer is needed to reduce reflections on the screen.[1]

CHAPTER 6 REFERENCES

1. Hendricks, D.E., Man/Computer Interaction in DARCOM. A paper presented at the 1980 AMEDD Psychology Symposium at Walter Reed Army Medical Center, Washington, DC, October, 1980.
2. Wright, P., and Barnard P., Just fill in this form — A review for designers. *Applied Ergonomics*, 1975, 6 (4), 213-220.

CHAPTER 6 CHECKLIST

	Yes	Not applicable	Not known*	no*
FORMS				
1. Does the sequence of data on the forms correspond to the sequence of data on the CRT?	☐	☐	☐	☐
2. Were the forms pilot tested?	☐	☐	☐	☐
3. Is there adequate space to answer on the form?	☐	☐	☐	☐
4. Are the spaces blank as opposed to being subdivided?	☐	☐	☐	☐
5. If the forms are subdivided into blocks, are the blocks 0.28 inches × 0.28 inches (7 mm × 7 mm)?	☐	☐	☐	☐
MANUALS				
6. Are the manuals:				
a. Self-explanatory?	☐	☐	☐	☐
b. Accurate?	☐	☐	☐	☐
c. Exhaustive?	☐	☐	☐	☐
7. Do they contain summary pages at the beginning?	☐	☐	☐	☐
8. Do they list the:				
a. Commands?	☐	☐	☐	☐
b. Entry/edit sequences?	☐	☐	☐	☐
c. Most common problems and their solutions?	☐	☐	☐	☐
9. Do the manuals each have a table of contents?	☐	☐	☐	☐
10. Do the manuals each have an index?	☐	☐	☐	☐
11. Do the examples in the manual include sequential pictures of a CRT screen?	☐	☐	☐	☐
12. Do the examples include keyboard actions?	☐	☐	☐	☐
13. Are the headings in the manual arranged horizontally?	☐	☐	☐	☐
14. Are the instructions in the manual arranged sequentially?	☐	☐	☐	☐
15. Do the manuals ask questions about one thing at a time?	☐	☐	☐	☐
16. Do the manuals contain only short, simple sentences ?	☐	☐	☐	☐
17. Do the manuals avoid choppiness in the text?	☐	☐	☐	☐
18. Are the sentences in the manuals active as opposed to passive?	☐	☐	☐	☐
19. Do the manuals use only words with positive connotations?	☐	☐	☐	☐
20. Do the manuals place the affirmative alternative before the negative in appropriate sentences?	☐	☐	☐	☐
21. Are negatives used only to increase emphasis?	☐	☐	☐	☐
22. Are decision trees used where appropriate instead of prose for instructions?	☐	☐	☐	☐

CHAPTER 6 CHECKLIST--Continued

	Yes	Not applicable	Not known *	no *
FICHE				
23. Is there frequent use of pictorials?	☐	☐	☐	☐
24. Is the microfiche clear or sharp rather than blurry?	☐	☐	☐	☐
25. Does microfiche have a black background with white letters?	☐	☐	☐	☐
26. Are users instructed regarding the necessity for frequent cleaning?	☐	☐	☐	☐
27. In selecting a microfiche reader:				
a. Is it a fanless model?	☐	☐	☐	☐
b. Are there distortions on the edges of the screen?	☐	☐	☐	☐
c. Are the characters on the screen large enough (0.156 inches - 3.96 mm), and are other legibility guidelines being followed?	☐	☐	☐	☐
d. Are hoods or polarizers available to reduce glare?	☐	☐	☐	☐

* Answers in these two columns require some action to obtain information or justify departing from the guidelines.

System Designer
Signature: _____ Date: _____

Approved by: _____ Date: _____

User acceptance: _____ Date: _____

CHAPTER 7
TRAINING

The purpose of this chapter is to:

- ***Provide guidelines for planning and organizing a training program.***

Human performance in using management information systems can be affected by many variables such as: training, design, man-machine interaction, environment, personal factors, supervision, co-workers, incentives, and both formal and informal communications. Human factors is involved not only in the design of the equipment, but also in such things as training, the allocation of job tasks, selection of personnel, and the design of the work environment. This chapter offers guidelines concerning training.

Major training factors

Users have to be trained to use a system; however, well designed systems will require a minimum of lecture-type training. As a rule, the user should be able to learn to use the system by actually working with it. Initial training may be done on dummy files or in a training mode which does not threaten the system. It should include access to, or direct instruction by, someone qualified to teach people how to use the system. No matter how well instructions are written, there will be some of those attempting to use the system who will ignore, misinterpret, or not understand the instructions. An instructor serves as a backup for those experiencing difficulty in learning to use the system. The instructor should be knowledgeable and able to explain the system to others. Manuals should be considered as an aid for the instructor(s) in organizing his tutorial efforts, and as an aid for the students in comprehending the material presented. If objective performance goals can be specified, they should be established along with a means of testing to ensure that students are meeting these goals.[1,2,3]

Training considerations

A training program should include:

- Computer assisted instruction where possible.
- A program specifically designed for the beginner.
- A brief review available for the infrequent user.
- A program for a user experienced in the use of another system.
- A minimum time requirement before the trainee begins actually working at the CRT.
- Access to the CRT, manual(s), microfiche, and printouts that are used by the typical user.
- Practice on a dummy file so that the trainee does not interfere with or damage regular files.
- A brief non-technical description of the system so that the user may have some grasp of the logic of the system.
- Information about the capability and limitations of the CRT and the systems, especially what the capabilities can do for the user in performing a task.
- A tour and brief non-technical explanation of the computer facility.
- The name and telephone number of the person to call for assistance.[4]

CHAPTER 7 REFERENCES

1. Gaines, B. R., and Facey, P. V., Some experience in interactive system development and application. *Proceedings of the IEEE*, 1975, June, 63 (6) 894-911.
2. Nickerson, R. S., and Pew, R. W., *Oblique Steps Toward the Human Factors Engineering of Interactive Computer Systems.* Report No. 2190, Cambridge, Massachusetts: Bolt, Beranek and Newman Inc., July 1971. Also published as an appendix to AD 7329137.
3. Harpool, J. D., Business Data Systems, William C. Brown Co., 1978
4. Murdick, R. G., and Ross, J. E., *Information Systems for Modern Management*, New Jersey: Prentice-Hall, Inc., 1975.

CHAPTER 7 CHECKLIST

	Yes	Not applicable	Not known *	no *
TRAINING				
1. Has formal training been designed for the system?	☐	☐	☐	☐
2. Was as much as possible of the training on-line?	☐	☐	☐	☐
3. Was the instructor familiar with the system?	☐	☐	☐	☐
4. Has the instructor been selected on the basis of his knowledge of the subject matter and his ability to communicate it to others?	☐	☐	☐	☐
5. Are the students given an instruction manual to aid in their comprehension of the material?	☐	☐	☐	☐
6. Have behavioral goals (i.e., performance level) been established to ensure that they can be achieved by both the instructor and the student?	☐	☐	☐	☐
7. Does the training include a program specifically designed for the beginner or naive user?	☐	☐	☐	☐
8. Is there a brief review for the intermittent user?	☐	☐	☐	☐
9. Is there a program for a user experienced in the use of another system?	☐	☐	☐	☐
10. Does the training program minimize the time before the user begins actually working at the CRT?	☐	☐	☐	☐
11. Does the training program incorporate the materials normally used at the workplace (e.g., manuals, printouts, etc.)?	☐	☐	☐	☐
12. Does the training allow the trainee to practice on a dummy file?	☐	☐	☐	☐
13. Is a brief, nontechnical description of system functioning available?	☐	☐	☐	☐
14. Does the training include information on the capabilities and limitations of the system?	☐	☐	☐	☐
15. Is there a tour and explanation of the central computer facility?	☐	☐	☐	☐
16. Is there a name and telephone number of a person to call when the user experiences difficulties with the system?	☐	☐	☐	☐

* Answers in these two columns require some action to obtain information or justify departing from the guidelines.

System Designer
Signature: _____ Date: _____

Approved by: _____ Date: _____

User acceptance: _____ Date: _____

CHAPTER 8
KEYBOARD AND INPUT DEVICES

The purposes of this chapter are to:

- ***Provide evaluative criteria in selecting specific types of terminal input devices***
- ***Determine the suitability of a particular terminal model to a specific user environment***

Section I. KEYBOARDS

NEED FOR RESEARCH

Research is needed to obtain data for many aspects of keypad design. Nevertheless, some guidelines and suggestions are possible.

The keyboard shown in Figure 8-1 is based on the proposed USA Standard Typewriter Pairing of the American Standard Code for Information Interchange(ASCII). To that standard, the following items were added: specific key locations for TAB SET, TAB CLEAR, CARRIAGE RETURN, BACKSPACE, and DELETE. The area to the right of the keyboard is designated as an optional telephone-array number keypad.[2]

The specific key locations were added for keys that are used often and in which a change in location could lead to a potentially serious negative transfer of skill problem. The optional number keypad was placed on the right because of the predominance of right-handed people in the population. A space was designated for special character keys so that these could be added while retaining all the standard keys.[2]

No data could be found concerning where fixed or variable function keys should be located, how many there should be, or whether they should be a different size or shape from standard keys. Fixed function is defined as functions that are so common across systems that separately labeled keys are usually provided. Variable functions are those functions that are system specific. Many vendors provide five fixed function keys — DITTO, RESET, BREAK, TRANSMIT, CONTROL, and a means for cursor movement. It would be very desirable to standardize the location of these keys. In the following examples , several potential placements of the fixed and variable function keys are shown. The functional keys can be grouped and placed on the left, right, on top, or below the suggested standard keyboard (fig 8-2). In Figure 8-3, functions are a third meaning for some keys. If only key fronts are used that can be seen when the typist's hands are on the typical ASDFG row of keys, there are at least 29 command spaces available on the suggested keyboard. Commands can be placed in an orderly logical fashion. For example, CHARACTER, WORD, LINE, SENTENCE PARAGRAPH, PAGE, REMAINDER, FILE represent an increasing amount of material to be acted on. A keyboard with the verb commands (operations) on the left and the noun objects on the right was developed in 1981.[2] Such a keypad has the advantage of compactness.

GENERAL RECOMMENDATIONS

Keyboards

The keyboard should have the overall appearance, feel, performance, and operating characteristics of an electric office typewriter. A skilled typist should be able to sit down and use it with minimal training.

Both the keyboard and terminal should operate quietly enough so that someone working at an adjacent desk may be aware of but not disturbed by its operation.

All commonly used controls (e.g., on/off, modem on/off) should be readily accessible to the user. Both the control itself and the control setting should be visible to the user.

Users of systems that communicate by telephone should have immediate access to a telephone for "dialing up" the computer. Once the connection has been made the telephone should be as unobtrusive as possible.[3]

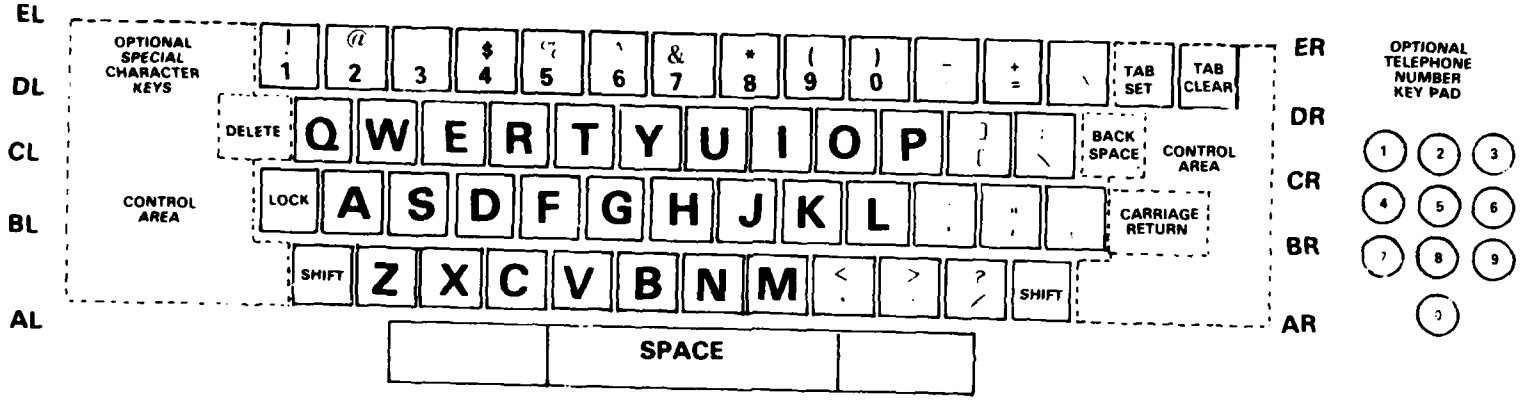


Figure 8-1. Suggested keyboard.

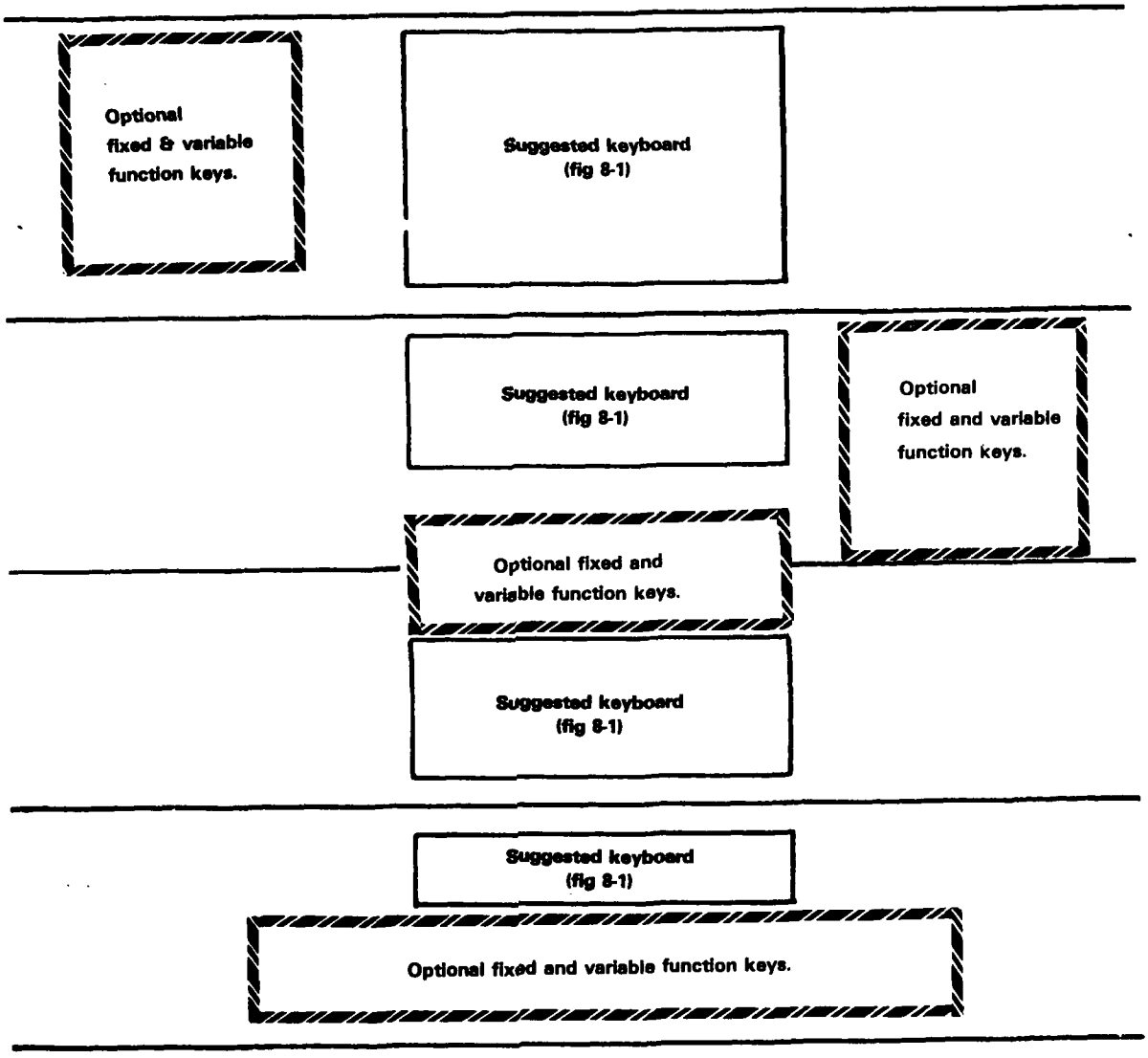


Figure 8-2. Placement of fixed and variable function keys.

The keypad should be separate from the CRT screen to facilitate adjusting it to a position comfortable for the user. When the screen is attached to the keyboard, many users will not be able to adjust the keyboard or the screen adequately in order to obtain the optimum or preferred height.

The weight of the keyboard should be sufficient to insure stability against unintentional movement.[4]

The key legends should be molded to the keytop so they are resistant to wear and abrasion.[4]

There should be a visible or audible warning signal provided in the event of system or CRT malfunction.[4]

The keyboard layout should minimize the effect of likely errors, especially those that are critical. For instance, the delete key should never be located next to the carriage return or other frequently used keys.[4]

An area approximately 2.4 in (60mm) deep on the front surface of the keyboard should be provided as a resting place for the users' hands.[4]

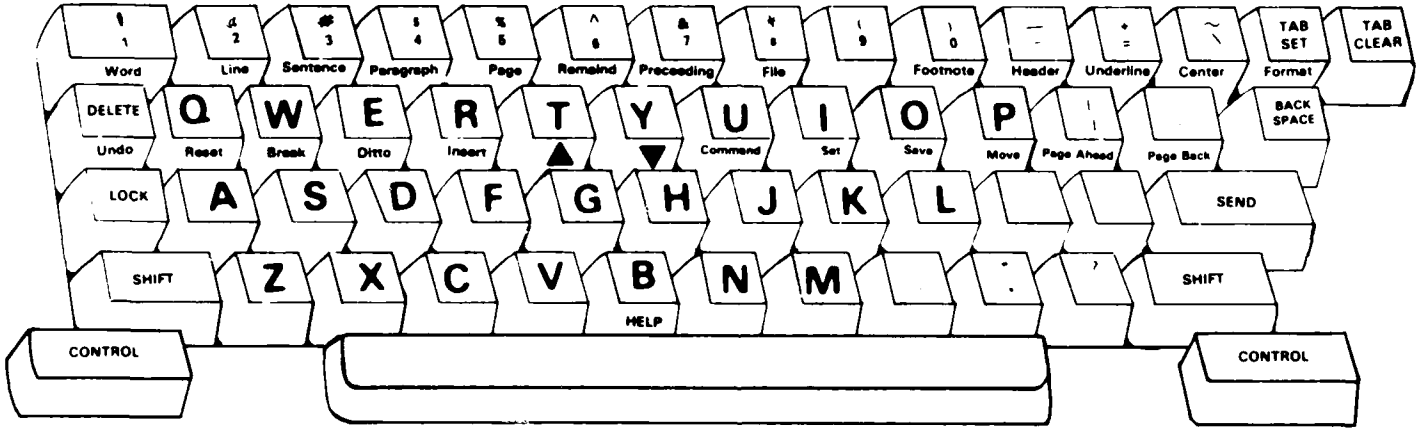


Figure 8-3. Suggested keyboard with addition of commands on the front of some character keys. (It requires control keys or another means of activating the functions.)

Alphabetic Keyboard

The QWERTY arrangement is the "de facto" standard arrangement for alphabetic characters on the keyboard. This arrangement, also called the "Sholes" arrangement, includes positions for the 26 alphabetic, 10 numeric, period, and comma characters.[4,5,6,7]

Numeric Keyboards

For certain applications, specifically those requiring rapid entry of large amounts of purely numerical information, a separate or auxiliary numeric keypad should be provided. This is in addition to the numeric keys in the central alphanumeric block. It should be located to the right of the main keyboard within easy reach of the user (fig 8-4). The placement on the right is supported by current accepted practice rather than empirical research. An alternative is to have a separate keypad which can be placed at the left, right, or below the main keyboard at the user's option.[4,6,8,9]

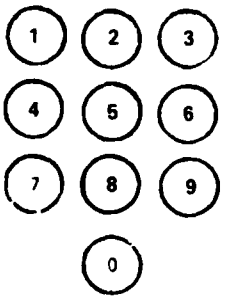


Figure 8-4. Optional telephone number key pad.

The layout of the numeric keypad has been the subject of controversy for some time. However, the available evidence supports using the telephone pad layout for numeric keypads, especially for unskilled users.[4,7,8,9,10]

Setting aside purely ergonomic considerations, it is desirable that the layout of keyboard numeric pads be compatible with telephone pads, particularly since push-button telephones are being used increasingly in conjunction with visual display terminals. The 1, 2, 3 (at the top of the pad) telephone layout should be adopted in order to avoid excessive transfer errors when both the terminal and the telephone are used together.[4,9,11]

Slope

Keyboard slope is defined as the angle of inclination of the working surface of the keyboard measured between the desk or table top and the upper keyboard surface. Although it has been recommended that the slope of the keyboard should be operator-adjustable between 10 degrees and 30 degrees, no reliable performance differences within these limits have been demonatrated. Therefore a non-adjustable slope within this range is acceptable.[3,12,13,14,15]

Operating Force

Operating force is defined as that force required to depress a key so that it will transmit a signal. The operating force of a terminal keyboard should be relatively small, ranging from 0.9 oz to 5.3 oz. Optionally, users should be able to adjust the force within this range to their liking.[4,8,16]

Displacement

Displacement is defined as the distance the key must travel when it is depressed in order to transmit a signal. The recommended displacement on terminal keyboards ranges between 0.03 in.-0.32 in. (0.8mm-8mm).[4]

Feedback

- Visual feedback for each key depressed is highly recommended. It promotes error detection, especially for unskilled users and is helpful during training.[4,8,10,17]
- Auditory feedback is generally not advised. It has been shown to have very little effect on user performance, and serves only to add to the noise in the environment.[7,8,10,18]
- Kinesthetic feedback (sensory) in the form of a distinct "bottoming out" when the keys are maximally depressed is very important. It is probably the most important type of feedback for skilled users and has been found to be a significant factor in the speed and accuracy of unskilled keyboard operators.[4,7,10,18]

Keyboard Interlock

A keyboard interlock is recommended to prevent the outputs from two or more simultaneously depress-

ed keys from either jamming the print mechanism or outputting an invalid keycode. There also should be a warning signal given when two keys are activated simultaneously.[4,8]

Keyboards should be equipped with an N-key rollover feature. That is, the code for a given key is transmitted upon depression of that key regardless of the state of any other key in the defined set.[4,19]

Size and Shape of Keys

The shape of the keytops should:

Aid the accurate location of the user's fingers.

Minimize reflections (fig 8-5).

Provide a suitable surface for the key legends.

Prevent the accumulation of dirt, dust, moisture, etc., on the surface from falling into the mechanism.

Be neither sharp nor uncomfortable to press.

Have a dished profile curvature for improved keyboarding accuracy.

Square keytops, approximately 0.5 in. (12.7mm) wide are preferred because they provide a bigger target area for a given spacing between key centers.[4,8,20,21]

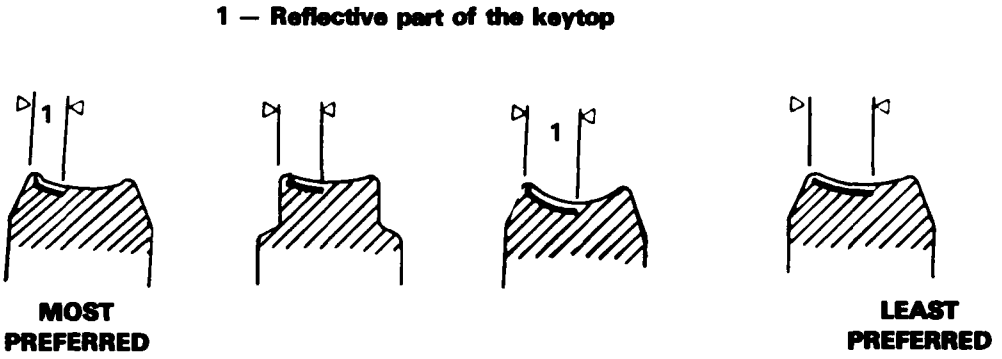


Figure 8-5. Keytop profile illustrating surface light reflection with unfavorable illumination.

Key Legend

The key legends should be explicit and easy to understand.

Alphanumeric legends should not be smaller than 0.12in. (3mm).

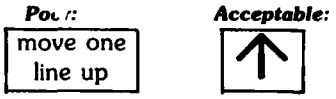
Color and Reflection of Keys

The surface of the keys should have a matte finish to reduce glare.

For standard keys, key color should be neutral; e.g., beige or gray, rather than a color which has a high reflectance, such as white. Color coding of non-standard keys may reduce search times and errors.

Critical function keys may be colored red.

Function keys should be labelled with standard symbols, the function itself, abbreviations, or codes in that order of preference. Standard symbols are ranked first because of their compactness and high information value. The function itself is ranked next if it does not require too many characters. Abbreviations are preferred to codes because they generally impose less of a memory burden.[4,7] For example:



Key Repeat

The provision of a facility to repeat certain characters or symbols continuously can be a very useful aid to the user. This can be provided either by having a separate REPEAT key to be depressed at the same time as any other key, or by using keys which automatically repeat when depressed for more than a short period of time, typically about half a second. The pressure to activate the repeat function might be adjustable by the user.[3]

For most applications, only a few characters, e.g., the underline symbol, need to be regularly repeated so that the selective use of automatic repeat keys may

be sufficient to provide this facility without otherwise requiring the user to use both hands for the operation of a separate REPEAT key. No empirical data was found concerning speed and errors using automatic repeat keys or a separate repeat key.[4]

Key Spacing

The spacing of the keys, measured between centers, should be between .71-.79 in. (18-20mm).[4]

Section II. OTHER INPUT DEVICES

The control methods considered are the four arrow keys (left, right, up, and down), the joystick, lightpen, mouse, rolling ball, and stylus. There is insufficient evidence to recommend one as the standard device. Research on the desirable physical and operating properties of these devices is also sparse. Comparative studies have been fairly meaningless either because the individual devices have been far from optimized or the error rates in the selection of single characters have been excessive.[22,23,24]

Joystick *(Isotonic, also known as displacement joystick)* *

The term "joystick" is used here to refer primarily to a device used to control the cursor. Isotonic means that movement of the joystick does not demand speed or force. The joystick consists of two potentiometers mounted at right angles and perpendicular to a vertical stick. Joystick controls may be used when the task requires precise or continuous control in two or more related dimensions.

Dynamic Characteristics

- Movement should be smooth in all directions, and rapid positioning of a follower on a display should be attainable without noticeable backlash, cross-coupling or need for multiple corrective movements.
- Control ratios, frictions and inertia should meet the dual requirements of rapid gross positioning and precise fine positioning.
- Recessed mounting or pencil attachments may be utilized as indicated in Figure 8-6, to provide more precise control.
- When used to create free-drawn graphics, the refresh rate for the follower on the CRT should be sufficiently high to ensure the appearance of a continuous track.
- The delay between control movement and the confirming display response should be minimized and should not exceed 0.1 seconds.
- Dimensions, resistance, and clearance should conform to criteria in Figure 8-6.
- The joystick should be placed sufficiently below and to the right of the keypad so that it does not interfere with the controls on the rest of the keypad.[25]

The advantages and disadvantages of the joystick can be seen in Table 8-1.

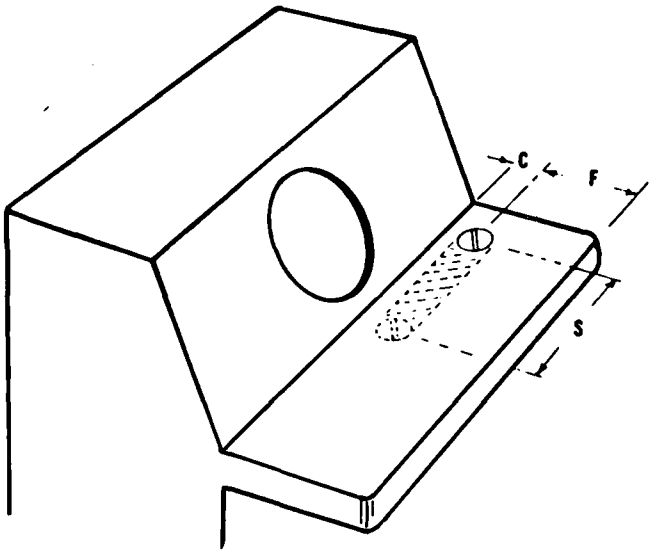
Table 8-1. Joystick advantages and disadvantages.[4]

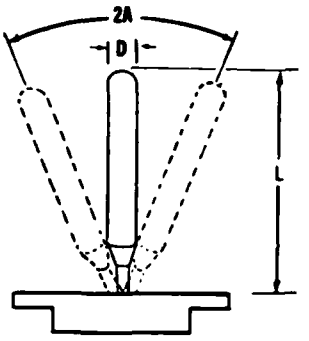
Advantages	*Disadvantages*
Can be used comfortably with minimum arm fatigue.	Slower than light pen for simple input.
Does not cover parts of screen in use.	Must be attached, but not to display.
Expansion or contraction of cursor movement is possible.	Unless large joystick, inadequate control/display ratio with positional control.
	The displacement of the stick controls both the direction and the speed of cursor movement.
	Difficult to use for free-hand graphic input.

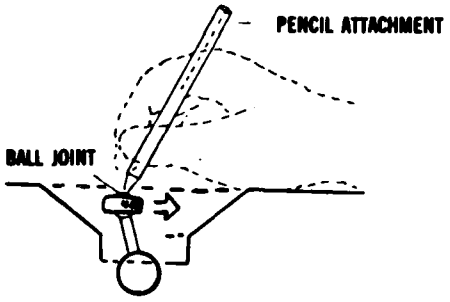
FOUR ARROW KEY CONTROL

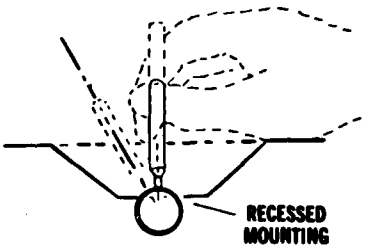
The four arrow key controls (left, right, up, and down) should allow movement of discrete steps and continous movement with continued depression of the particular key. The advantages and disadvantages can be seen in the following table.

* The isometric joystick (stiff stick) will not be considered since most of the MIS applications do not require dynamic tracking.









	DIMENSIONS		RESISTANCE	DISPLACEMENT	CLEARANCE		
	D DIAM	L LENGTH		A	S DISPLAY CL TO STICK CL	C AROUND STICK	F STICK TO SHELF FRONT
MINIMUM	6.5 mm (1/4")	75 mm (3")	3.3 N (12 oz.)		0		120 mm (4-3/4")
MAXIMUM	16 mm (5/8")	150 mm (6")	8.9 N (32 oz.)	$\frac{\pi}{4}$ rad (45°)	400 mm (15-3/4")	★	250 mm (9-7/8")

★ Maximum stick excursion plus 100 mm (4").

Figure 8-6. Isotonic Joysticks.

Table 8-2. Four arrow cursor control advantages and disadvantages.

Advantages	*Disadvantages*
Allows accurate positioning of the cursor.	Should not be used for free-hand graphics.
May provide positive transfer and advantages associated with touch typing.	
Allows for non-destructive movement of the cursor.	
Requires little or no training.	

LIGHT PENS:

A light pen is a light sensing device. If the light pen can be adapted as a bar code reader, and coding is the main way of entering data, it is the preferred cursor control for:

- Rapid input functions not demanding preciseness.
- Detecting the presence of a computer generated track.
- Serving as a two-axis controller in place of a grid and stylus device.

Light pens should:

- Be equipped with a separate activating device. For most purposes, a push button switch, located at the tip, requiring from 2-5 oz. of force to operate, is preferred. Feedback should be provided when the activating device is operated.
- Project an illuminated circle onto the display screen highlighting the area where the pen is positioned.
- Produce some indication that it has activated and that the input has been received by the system.
- Be between 4.7 and 21 inches long, and .03 and .08 inches in diameter.
- Be attached to the lower right side of the terminal screen when not in use.
- Provide a smooth movement of the follower when used as a two-axis controller. The refresh rate for the follower should be high enough to ensure the appearance of a continuous track whenever it is used to create graphics input.[25]

The advantages and disadvantages of light pens are shown in Table 8-3.

Table 8-3. Light pen advantages and disadvantages.[4]

Advantages
Fast for simple input.
Good for tracking moving objects.
Minimal perceptual-motor skill needed.
Good for gross drawing.
Efficient for successful multiple selection.
User does not have to scan to find a cursor somewhere on the screen.
May be adaptable to bar coding.
Disadvantages
May not feel natural to user, like a real pen or pencil.
May lack precision because of the pen's aperature, distance from the CRT screen surface, and parallax.
Contact with the computer may be lost unintentionally.
Frequently required simultaneous button depression may cause slippage and inaccuracy.
Must be attached to terminal, which may be inconvenient.
Glare problem if tube tilted to reduce arm fatigue.
Fatiguing if tube is 90 degrees to work surface.
May require user to flash the screen to find pen, if pointed to dark area.
One-to-one input only (zero order control).
May be cumbersome to use with alternate, incompatible entry methods such as keyboard.
Tends to be used for purposes other than originally intended (e.g., for key depression).
Tends to be fragile.
May obstruct portion of screen when used.
Care must be taken to provide adequate "activate" area around choice point.
Cannot be used on gas panel.

MOUSE *(Free-Moving XY Controller)*

The mouse is a small device used on any flat surface to generate X and Y coordinate values controll-

ing the position of the follower on the associated display. It may be used for data selection or to coordinate values. It should be used for zero order control only (i.e., generation of X and Y outputs by the controller results in proportional displacement of the follower). It should not be used to create free-drawn graphics.

Dynamic Characteristics

Its design and placement on the maneuvering surface should be such as to allow the operator to consistently orient the controller to within 10 degrees (± 175 mrad) of the correct orientation without visual reference to the controller. For example, when the operator grasps the controller in what seems to be the correct orientation and moves it in a straight line along what is assumed to be the y axis, then the direction of movement of the follower on the CRT should be between 350 degrees and 10 degrees (6110 and 175 mrad).

The controller should be easily movable in any direction without a change of grip and should result in smooth movement of the follower in the same direction ± 10 degrees (175 mrad). The controller should be operable with either hand. Moving the controller from side to side should move the follower from side to side on the display for an automatic sequencing mode of operation. In any application that would allow the controller to drive the follower off the edge of the display, indicators should be provided to assist the operator in bringing the follower back onto the display.[25]

Dimension and Shape

The mouse should have no sharp edges but should be shaped roughly as a rectangular solid, with limiting dimensions (Table 8-4).

The advantages and disadvantages of the mouse are shown in Table 8-4a.

Table 8-4. Mouse (free-moving XY controller) dimensions.

	Min.	*Max.*
Width (spanned by thumb to finger grasp)	1.6 in (40 mm)	2.8 in (70 mm)
Length	2.8 in (70 mm)	4.7 in (120 mm)
Thickness	1.0 in (25 mm)	1.6 in (40 mm)

Table 8-4a. Mouse (free-moving XY controller) advantages and disadvantages.

Advantages	*Disadvantages*
Relatively fast.	Requires additional flat work surface.
Has low error rates for large targets.	Difficult to use for free-hand graphic input.
	High error rates with small targets.
	Lost time when mouse held backwards or sideways.
	Some training needed.
	Slippage of wheels sometimes a problem.

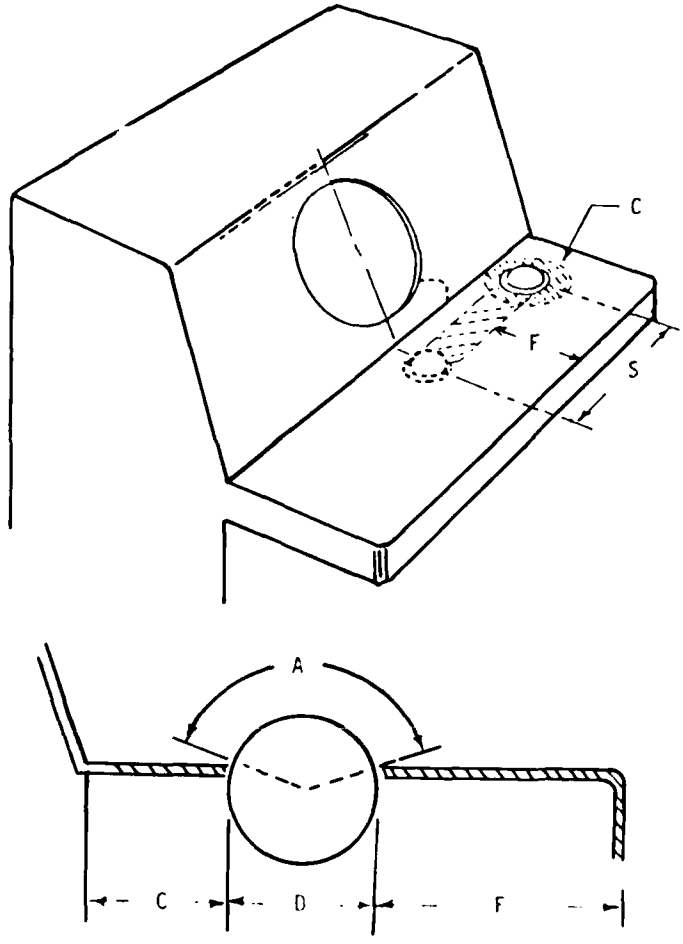
ROLLING BALL *(also known as track ball, ball tracker, joyball, and ball control)*

The rolling ball device is suspended on low-friction bearings and may be used for various control functions such as data pickoff on a display. The ball does not return automatically to the point of origin; interfacing systems must provide this. Because the ball can be continuously rotated in any direction, it is well suited for applications where there may be accumulative travel in a given direction. In any application that would allow the ball to drive the follower off the edge of the display, indicators should be provided to advise the user how to bring the follower back onto the display. The rolling ball should be used only as a zero order control (i.e., a given movement of a ball makes a proportional movement of the follower on the display).[25]

Dimensions, resistance, and clearance

Dimensions, resistance, and clearance should conform to the criteria in Figure 8-7. The smaller diameter ball controls should be used only where space availability is very limited and when there is no need for precision. Preferred mounting is on a shelf or desk top.[25]

The advantages and disadvantages of the rolling ball are shown in Table 8-5.



	DIMENSIONS		RESISTANCE		CLEARANCE		
	D DIAM	A SURFACE EXPOSURE	PRECISION REQUIRED	VIBRATION OR ACCEL CONDITIONS	S DISPLAY CL TO BALL CL	C AROUND BALL	F FALL TO SHELF FRONT
MINIMUM	50 mm (2")	1545 mrad (100°)			0	50 mm (2")	120 mm (4-3/4")
MAXIMUM	150 mm (6")	2445 mrad (140°)	1.0 N (3.6 oz.)	1.7 N (6 oz.)	320 mm (12-5/8")		250 mm (9-3/4")
PREFERRED	100 mm (4")	2095 mrad (120°)	0.3 N (1.1 oz.)				

Figure 8-7. Ball controls.

Table 8-5. Rolling ball advantages and disadvantages

Advantages	*Disadvantages*
Ball excellent for three-dimensional rotation of objects.	Inconvenient to have integrated "activate" switch on the ball.

STYLUS DEVICES

These provisions cover various techniques which use some means of establishing an X and Y grid with a stylus for designating specific points on that grid for control purposes (e.g., time-shared X and Y potential grids and a voltage-sensitive stylus). Stylus devices may be used to pickoff data from a CRT, enter points on a display, generate free-drawn graphics and similar control applications. The grid may be on a transparent medium allowing stylus placement directly over corresponding points on the display, or it may be displaced from the display in a convenient position for stylus manipulation. In either case, a follower (bug, mark, hook, etc.) should be presented on the display at the coordinates selected by the stylus. Devices of this type should be used only for zero order control functions (i.e., displacement of the stylus from the reference position causes a proportional displacement of the follower).[15]

Dynamic Characteristics

- Movement of the stylus on the grid surface should result in smooth movement of the follower in the same direction.
- Discrete placement of the stylus at any point on the grid should cause the follower to appear at the corresponding coordinates and to remain steady in position so long as the stylus is not moved.
- The refresh rate for the follower should be sufficiently high to ensure the appearance of a continuous track whenever the stylus is used for generation of free-drawn graphics.[25]

Dimensions and Mounting

Transparent grids which are used as display overlays shall conform to the size of the display. Remote grids should approximate the display size and should be mounted below the display in an orientation to preserve directional relationships to the maximum extent (i.e., vertical to the display).[25]

The advantages and disadvantages of stylus devices are shown in Table 8-6.

Table 8-6. Stylus devices advantages and disadvantages[4]

Advantages	*Disadvantages*
Excellent for graphic entry.	Extra space required on work surface.
It can be designed so that the user works on a horizontal surface.	Displacement of visual feedback from motor activity may cause coordination problems.
Multi-purpose input device.	
Minimal difficulty going from graphic input to character input if character recognition is built into the system and the tablet is used for this input. Entering hand-printed characters to be recognized by the system is very slow (fewer than 40 characters/minute), compared with typewriter entry (averaging 200 characters/minute).	

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CHAPTER 8 CHECKLIST

	Yes	Not applicable	Not known *	no *
KEYBOARD/INPUT DEVICES				
1. Does the keyboard follow the proposed standard keyboard (fig 8-1; page 8-2)?	☐	☐	☐	☐
2. For all applications requiring a significant amount of high numeric input, is there a separate numeric keyboard either located to the right of the main keyboard or movable with user selection of location?	☐	☐	☐	☐
3. Is the numeric keypad arranged in the telephone format; i.e., 1, 2, 3, across the top?	☐	☐	☐	☐
4. Does the terminal have the overall appearance and feel of an electric office typewriter?	☐	☐	☐	☐
5. Is the terminal quiet during operation?	☐	☐	☐	☐
6. Are all controls both visible and operable without necessitating undue stretching or gross posture changes?	☐	☐	☐	☐
7. Are telephones readily available at each terminal worksite where the communication to the main computer is done by telephone?	☐	☐	☐	☐
8. Is the keyboard detachable from the CRT?	☐	☐	☐	☐
9. Is the keyboard heavy enough to prevent unintentional movement?	☐	☐	☐	☐
10. Are the key legends molded to the keytop?	☐	☐	☐	☐
11. In the event of system or CRT malfunction, is there a visual or auditory warning signal given to the user?	☐	☐	☐	☐
12. Is the layout of the keyboard designed in such a way that it minimizes the chance of likely errors? (For instance, is the "delete" key separated from other frequently used keys?)	☐	☐	☐	☐
13. Is a free area of approximately 2.4 inches (60 mm) provided on the front surface of the keyboard as a resting place for the user's hands?	☐	☐	☐	☐
14. Are the fixed and variable function keys grouped according to their purpose; i.e., all edit keys together?	☐	☐	☐	☐
15. Are the function keys labelled with standard symbols, the function itself, or the function's abbreviation?	☐	☐	☐	☐
16. Is the slope of the keyboard between 10° and 30°?	☐	☐	☐	☐
17. Is the operating force of the terminal keyboard between 9 ounces and 5.3 ounces?	☐	☐	☐	☐
18. Is the key displacement between .03 inches and .32 inches?	☐	☐	☐	☐
19. Is the user provided visual feedback of his keyed input?	☐	☐	☐	☐

(Keyboard/Input Devices--Continued)	Yes	Not applicable	Not known *	no *
20. Does the keyboard provide kinesthetic feedback in the form of "bottoming out" when the keys are maximally depressed?	☐	☐	☐	☐
21. Is the keyboard provided with an interlock system to prevent two keys from being activated simultaneously?	☐	☐	☐	☐
22. Is the keyboard equipped with an N-key rollover feature?	☐	☐	☐	☐
23. Is an auditory warning signal given when two keys are depressed simulatneously?	☐	☐	☐	☐
24. Does the keytop have a dished profile curvature?	☐	☐	☐	☐
25. Are the keytops approximately .5 inches (12.7mm)wide?	☐	☐	☐	☐
26. Is the shape of the keytops approximately square?	☐	☐	☐	☐
27. Are the labels on the keys explicit to the user?	☐	☐	☐	☐
28. Are the legends or symbols at least .12 inches (3 mm)?	☐	☐	☐	☐
29. Do the key surfaces have a matte finish to reduce glare?	☐	☐	☐	☐
30. Is there a "repeat" provision for characters which might be used in multiples?	☐	☐	☐	☐
31. Is the center-to-center spacing of the keys between .71 inches and .79 inches (18-20 mm)?	☐	☐	☐	☐
32. Where the joystick is employed, are the following conditions met:				
a. Is the movement smooth in all directions?	☐	☐	☐	☐
b. With no noticeable blacklash?	☐	☐	☐	☐
c. With no cross-coupling?	☐	☐	☐	☐
d. With no need for multiple corrective movements?	☐	☐	☐	☐
e. Does it allow rapid gross positioning?	☐	☐	☐	☐
f. Precise fine positioning?	☐	☐	☐	☐
g. Are recessed mounting or pencil attachments used to privide greater precision control?	☐	☐	☐	☐
h. Is the refresh rate of the screen sufficiently high to give the appearance of a continuous track?	☐	☐	☐	☐
i. Is the delay between control movement and corresponding display response a maximum of .1 seconds?	☐	☐	☐	☐
j. Is the length of the joystick between 3 inches and 6 inches (75 mm to 150 mm)?	☐	☐	☐	☐
k. Is the diameter of the joystick between .25 inches and .68 inches (6.5 mm - 16 mm)?	☐	☐	☐	☐
l. Is the resistance of the joystick between 12-32 ounces (3.8-8.9 N)?	☐	☐	☐	☐
m. Is the maximum displacement of the joystick 45°?	☐	☐	☐	☐
n. Is the display clearance to stick clearance between 0-15.75 inches (0-400mm)?	☐	☐	☐	☐
o. Does the clearance around the stick allow maximum stick excursion plus 4 inches (100mm)?	☐	☐	☐	☐

(Keyboard/Input Devices--Continued)

	Yes	Not applicable	Not known *	no *
p. Is the joystick located where it will not interfere with the operation of the keypad?	☐	☐	☐	☐
33. If the arrow keys are used for cursor control, do they allow movement by discrete steps and continuous movement with continued depression of a particular key?	☐	☐	☐	☐
34. The following questions apply to the use of the light pen as an input device:				
a. Does the light pen have an actuating mechanism?	☐	☐	☐	☐
b. Is there feedback concerning exact location of light pen placement on the screen (e.g., an illuminated circle)?	☐	☐	☐	☐
c. Is the user given feedback that the light pen has actuated, and the input has been received by the system?	☐	☐	☐	☐
d. If the light pen is being used as a two-axis controller, does the movement on the CRT surface result in a smooth movement of the follower?	☐	☐	☐	☐
e. Is the refresh rate of the follower sufficiently high to insure the appearance of a continuous track?	☐	☐	☐	☐
f. Is the light pen between 4.7 inches and 7.1 inches (120-180 mm) long?	☐	☐	☐	☐
g. Is the diameter of the light pen between .3 inches and .8 inches (7-20 mm)?	☐	☐	☐	☐
h. Is there a clip located conveniently on the lower right side of the CRT to hold the light pen when not in use?	☐	☐	☐	☐
35. The following questions apply when the mouse is used as a data input device:				
a . Does the design of the controller and placement of the maneuvering surface allow the operator to consistently orient the mouse to within 10° of the correct orientation without visual reference to the mouse?	☐	☐	☐	☐
b. Is the mouse easily movable in any direction without a change in hand grasp?	☐	☐	☐	☐
c. Does movement of the mouse result in movement of the follower in the same direction ± 10°?	☐	☐	☐	☐
d. Is an indicator provided to bring the follower back on to the display after it has been driven off the edge?	☐	☐	☐	☐
e. Is the mouse approximately rectangular with no sharp edges?	☐	☐	☐	☐
f. Do the dimensions of the mouse conform to the following limits:				
(1) Width — 1.6 in (40 mm) - min — 2.8 in (70 mm) - Max	☐	☐	☐	☐
(2) Length — 2.8 in (70 mm) - Min — 4.7 in (120 mm) - Max	☐	☐	☐	☐
(3) Thickness — 1.0 in (25 mm) - Min — 1.6 in (40 mm) - Max	☐	☐	☐	☐

(Keyboard/Input Devices--Continued)

	Yes	Not applicable	Not known *	no *
36. The following questions apply when a ball controller (track ball) is being used as an input device:				
a. If the follower is driven off the display, are there indicators to advise the user how to bring the follower back on to the display?	☐	☐	☐	☐
b. Is the ball control capable of rotation in any direction?	☐	☐	☐	☐
c. Do the control ratios meet the dual requirement of:				
(1) rapid gross positioning, and	☐	☐	☐	☐
(2) precise fine positioning?	☐	☐	☐	☐
d. Do the physical characteristics conform to the following criteria?				
(1) Diameter — 2 in (50mm) — min	☐	☐	☐	☐
6 in (150mm) — Max	☐	☐	☐	☐
4 in (100mm) -- Pref	☐	☐	☐	☐
(2) Surface exposure — 1545 mrad/100° — Min	☐	☐	☐	☐
2445 mrad/140° — Max	☐	☐	☐	☐
(2095mrad/120° — Pref)				
(3) Precision required — 3.6 oz (1.0N) — Max	☐	☐	☐	☐
(1.1 oz (.3 N) — Pref)				
(4) Vibration or acceleration conditions — 6 oz (1.7N) — Min	☐	☐	☐	☐
(5) Display clearance to ball clearance — 12.63 in (320mm) — Max	☐	☐	☐	☐
(6) Around ball — 2 in (50mm) — Min	☐	☐	☐	☐
Ball to shelf front — 4.75 in (120mm) — Min	☐	☐	☐	☐
9.75 in (250mm) — Max	☐	☐	☐	☐
37. The following questions pertain to the use of grid and stylus devices:				
a. Will placement of the stylus at any point on the grid cause the follower to appear at the corresponding coordinates?	☐	☐	☐	☐
b. Will the follower then remain in steady position if the stylus is not moved?	☐	☐	☐	☐
c. Is the refresh rate for the follower sufficiently high to ensure the appearance of a continuous track?	☐	☐	☐	☐
d. Do grids which are displaced from the display approximate the display size?	☐	☐	☐	☐
e. Are the displaced grids mounted below the display in an orientation to preserve directional relationships to the maximum extent?	☐	☐	☐	☐

* Answers in these two columns require some action to obtain information or justify departing from the guidelines.

System Designer
Signature: _____ Date: _____

Approved by: _____ Date: _____

User acceptance: _____ Date: _____

CHAPTER 9
SCREENS AND PRINTERS

The purposes of this chapter are to:

- ***Identify various physical screen characteristics of the display that affect legibility of the display.***
- ***Identify printer and paper qualities that produce readable, usable output.***

Section I. SCREENS

LEGIBILITY

One of the main requirements of a visual display is that the displayed information must be seen easily and clearly. The main factors in the legibility of the display are: luminance, contrast, character generation, font, size, and spacing.

In general, the screen should be designed to provide as much necessary information as possible on any one display frame. In order to provide the maximum amount of information within a display of a given size, the dimensions of the graphic elements (e.g., line width, character height) are kept to a minimum determined by the range of normal viewing distances. The legible minimum is directly affected by contrast and luminance. For a given graphic-element size, legibility can be enhanced by increasing either or both of these variables within certain limits. Increased luminance contributes to display legibility by increasing the acuity of the eye; that is, the ability to separate fine details is improved.

Although an increased level of luminance may increase the acuity of the eye, it reduces the ability to discern luminance differences (contrast). The minimum discernable luminance difference is, over a broad-range, a fixed percentage of the average luminance level. The higher the average luminance, the less sensitive the eye to luminous differences. The absolute luminance values of the image and background surfaces of a display are, within reasonable limits, not nearly as important as the relative luminance values.

Luminance

Luminance *brightness* is defined as the amount of light emitted from the display surface or any object as viewed by the observer. Luminance is measured in foot-Lamberts (fL). It pertains to both the display background and the characters.

- The level of luminance recommended for the display background is 5 fL.
- The level of luminance recommended for characters on a CRT is 50 fL. The range of 20-70 fL is considered acceptable providing adequate contrast is available.[1,2,3,4]
- The luminance level of characters should be adjustable within predetermined limits.[5]
- The luminance range of surfaces immediately adjacent to the display should be between 10% and 100% of screen background luminance.[6]
- With the exception of emergency indicators, no light source should be brigher than the display characters.[6]

Contrast Ratio

Contrast between the characters on the display and the background of the display is one of the primary factors affecting legibility and user performance in display systems. The contrast ratio contributes to both the legibility of the display and its "looking-good" appearance. The percent of contrast, or extrinsic contrast ratio, is defined as the ratio of the character brightness (Bo) to the display background brightness (Bd). This assumes that the display system designer knows the character and background brightness.[2,7,8,9,10,11] The formula for the percent of contrast is:[8]

$$\% C = \frac{Bo - Bd}{Bo} \times 100\%$$

Example. If the characters on a display have a luminance of 50 fL and the display background has a luminance of 5 fL, we would have a percent of contrast of 90%.

$$\% C = \frac{50 - 5}{Bo} \times 100 = 90\%$$

This value can be expressed as a ratio (9:1), a numeric value (9.0), or a percentage (90%).

- A 90% contrast is optimum.[4,5,11]
- An 88% contrast is the minimum recommended. The maximum and minimum values for contrast are very close because display alphanumerics have a tendency to blur due to gradual (rather than sharp) symbol background luminance.[1,5]
- The majority of displays have bright lines on a dark background but the capability should be provided for reversing contrast.[5,12,13]

Surround Contrast

There is an ambient-light effect which must be taken into account. Light reflected off the surroundings or directed into the viewer's eyes (commonly called glare) can alter the luminance-adaptation level of the eyes and affect the legibility of the display. The "surround" contrast is defined as the ratio between the luminance level of the surroundings and the background luminance of the display. The ideal surround-contrast ratio is 1:1. If the surrounding luminance is markedly lower than that of the display background, eyestrain may result. But as the surround contrast ratio increases toward 10:1, the display contrast ratio must be at least doubled to maintain an adequate level of viewing comfort and legibility (Table 9-1).

Character Generation

Character generation is defined as the process of converting a coded digital description of a character into an image of that character. Dot matrix is the character generation technique most commonly used for text processing CRTs using the raster scanning principle (i.e., each character is defined by a selected set of dots from a rectangular matrix of dots as the electronic beam scans through its raster pattern.) The matrix is defined by the number of horizontal and vertical dots (in that order) which determines the maximum possible horizontal and vertical extent of the character image; e.g., 5×7, 7×9, etc.[14]

- The most commonly used matrix is the 5×7 dot matrix. This size matrix permits considerable flexibility in shape and form of symbols and provides a readable set of alphanumeric characters.

Table 9-1. Surround contrast ratios.*

Illumination level guidelines for maintaining proper brightness contrast between visual task and background.

	** Environmental Classification		
Comparison	*A*	*B*	*C*
Between tasks and adjacent darker surroundings	3:1	3:1	5:1
Between tasks and adjacent lighter surroundings	1:3	1:3	1:5
Between tasks and more remote darker surfaces	10:1	20:1	!
Between tasks and more remote lighter surfaces	1:10	1:20	!
Between light fixtures and adjacent surfaces	20:1	!	!
Between the immediate work area and the rest of the environment	40:1	!	!

* (From *Human Factors Design Handbook*, by W. E. Woodson, Copyright © 1981 by McGraw-Hill Inc., used by permission of McGraw-Hill Book Company.

** A Interior areas where reflectance of entire space can be controlled for optimum visual conditions. B Areas where the reflectance of immediate work area can be controlled, but there is only limited control over remote surroundings. C Areas (indoors and outdoors) where it is completely impractical to control reflectances and difficult to alter environment conditions.

! Brightness ratio control not practical

NOTE: Direct glare can arise from a light source within the visual work field. It should be controlled by:

1. Avoiding bright light sources within 60 degrees of the center of the visual field. Since most visual work is at or below the eye's horizontal position, placing light fixtures high above the work area minimizes direct glare.
2. Using indirect lighting.
3. Using more relatively dim light sources, rather than a few very bright ones.
4. Using polarized lights, shields, hoods, or visors to block the glare in confined areas.

- A 7×9 matrix is the minimum needed for lower case letters.
- Legibility is affected by the number of dot elements in the basic matrix. As a rule, the more dots, the more legible the character as can be seen from Figure 9-1.[4]
- For applications where a greater array of characters or symbols is desired, a design based on a 7×11 or a 9×15 matrix should be used.

Character Font and Error Minimization

Specific character fonts for CRTs should be considered only if the dot matrix character generation technique is not used. If a specific font is used, the Lincoln/Mitre font shown in Figure 9-2 is recommended because its characters are highly identifiable resulting in faster identification and fewer errors. No adequate research on lower case fonts was found but the principles seen in Figure 9-2 can be generalized.[5,15]

- Character font is defined as the style and size of print. Both upper and lower case characters should be included in the character font.
- Each character should be made as recognizable as possible which depends on the emphasis given to such featu.es as diagonals, flat tops, and loops. Some examples of how certain characters can be distorted to the point of confusion are shown in Figure 9-3. The following points are important:
- The letter A must have a clearly delineated space above the horizontal stroke. The two sides of the letter should not be too close together.
- The letter B should have approximately equal loops at the top and bottom.
- Cs and Gs are easily confused with each other or with Os if the break is not clearly discernible, if the horizontal stroke of the G is not long enough, or if the O tends to appear too square.
- The D should have a relatively large rounded loop on a straight line. The O should be round rather than oblong.
- The E must not have its horizontal stroke too close together.
- The M and the W must have sufficiently long center sections.
- The P must have a large enough loop, but not too large.
- The S and the 5 are easily confused if the S is too square or if the horizontal top of the 5 is not long enough.
- The I and the 1 are easily confused with each other unless they are made to look different. In this instance the serif is perhaps most helpful.
- The U and the V are easily confused unless the vertical sides of the U are maintained, as opposed to the slanting sides of the V.
- The Y needs a long tail to be discernible from the V. However, the V-shaped top also must be definite to keep the Y from being mistaken for a T.
- The top loop of the number 8 should be only slightly smaller than the bottom loop. If the top loop is too small, the character is often not recognized quickly as an 8.
- When the 6 and 9 have loops that are too large and tails that are too curved, they are not easily recognized. The loops must be readily apparent, but the tails need to be relatively straight.

Character Size

The following requirements for character size are based on an assumed viewing distance of approximately 20″ (50cm) and an arc (visual angle) of 15-20′ (fig 9-4).

Minimum character height:	0.156 in (3.96mm)
Max character height for 5×7 dot matrix:	0.2 in (4.5mm)
Character width to height ratio:	⅔-⅘ Optimal 75%
Stroke width to character height ratio:	1/9-⅕ Optimal ⅕
Minimum number of raster lines:	10

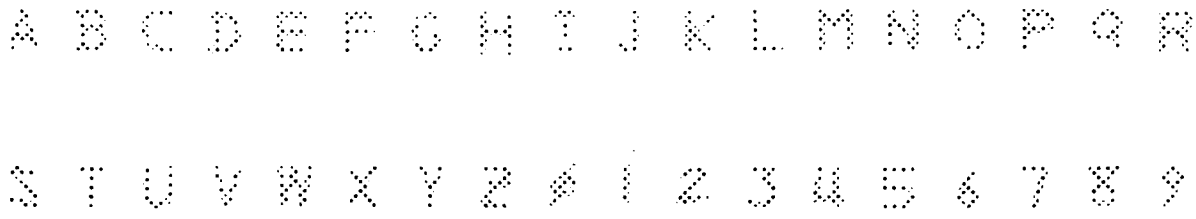
The optimum size of letters and numerals on CRT displays is a function of viewing distance, contrast, and whether or not letters and numerals move or are in fixed positions.[4,5,11,13,14,16,17]

Character Spacing

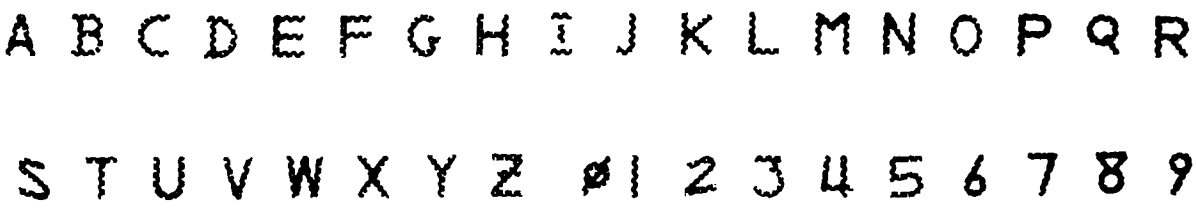
- To insure adequate perception on the display screen, character spacing between individual characters should not be less than 20% and in most cases no greater than 50% of the character width.[14]
- Spacing between words should be proportional to inter-letter spacing. In printed text, normal spacing is one character width.
- Normal line spacing on the display screen should be such that ascenders and descenders do not intrude into the characters on the line above or

below. Normal interline spacing should be between 100% and 150% of the height of the characters.[14,16]

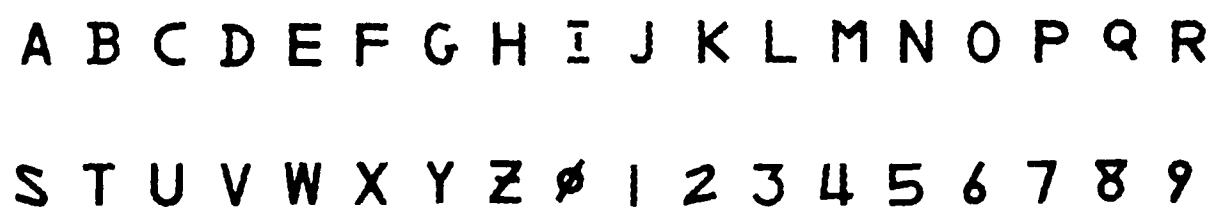
- Immediately adjacent ascenders and descenders on the display screen should not overlap or intersect.[14]



3 X 5 L/M SYMBOLS



5 X 7 L/M SYMBOLS



7 X 11 L/M SYMBOLS

9 X 15 L/M SYMBOLS

Figure 9-1. Symbols formed by different numbers of dots.

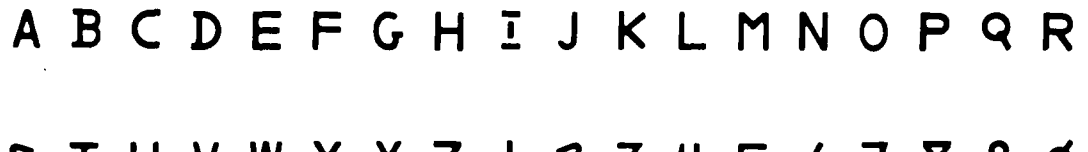


Figure 9-2. Revision of Mackworth Symbols by Lincoln Lab (top); Revision of Mackworth Symbols by the MITRE Corporation (bottom).

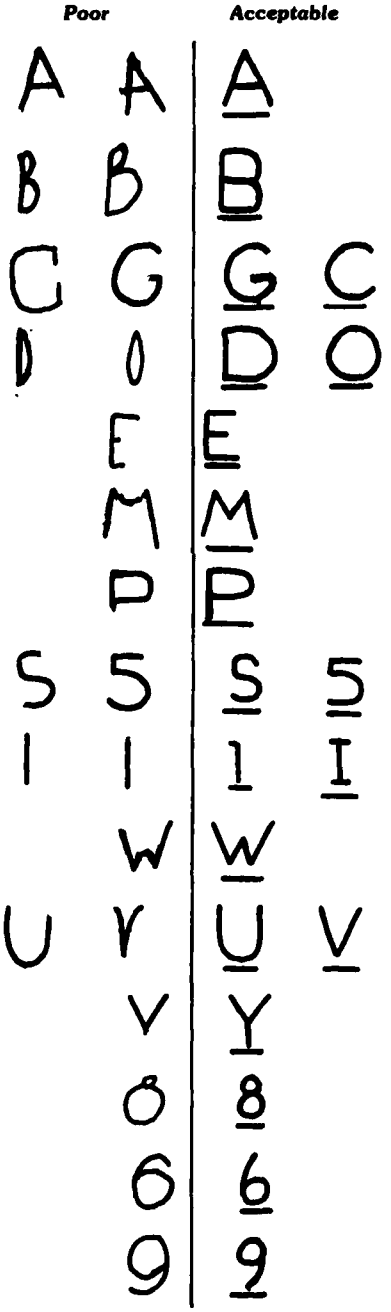


Figure 9-3. Example of character distortion.

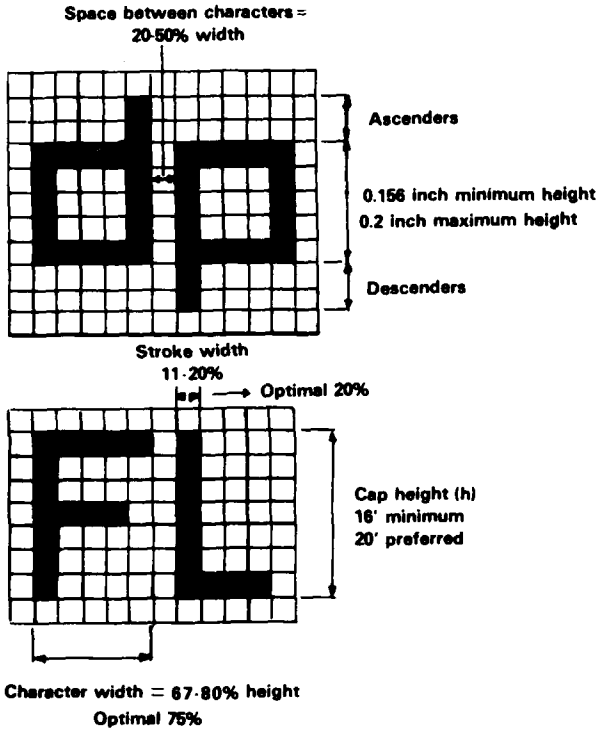


Figure 9-4. Recommended character dimension and spacings (as typically implemented on a 7 x 5 matrix; the matrix is not normally seen on a working display).

VIEWING ANGLE

Optimum viewing angles are important design parameters in laying out a console.[17]

- All areas of the display surface should be legible at least 30 degrees from the normal viewing angle.[9,11,14,18]
- The screen angle should be nearly perpendicular to the viewer's line of sight but placed so that reflection from overhead lighting is avoided. Thus, the angle between the viewer and the screen should be adjustable.[13]

PHOSPHOR TYPE & FLICKER

Phosphor is the light-emitting coating which is applied to the inside surface of a CRT screen. Phosphors are designated by a "P" number, such as P31. Phosphors for a CRT are chosen for their grain, burn resistance, color of the emitted light, and persistence.

Phosphors with a fine, uniform grain are chosen for sharp and well-defined images.

- Phosphors used with text processing CRTs should be either highly or moderately burn resistant since the burn rate effects the longevity of the CRT.
- The color of the phosphors typically used with text processing CRTs should fall in the green-yellow category. These include P_{31}, P_7, P_1, and P_{39}.[14]

SCREEN SIZE

The screen size for CRTs is variable depending upon the purpose, and is always stated in terms of the length of the diagonal. The screen size depends on what is being displayed, what the observer is looking for, the viewing distance, the required character size, or number of characters. These must be determined in order to establish minimum screen size.[4,14,19]

- The minimum recommended size for a desk-top CRT is 12" (305mm)[7,14,19]
- The size of the usable display area (i.e., area of surface where information and data are displayed) should be smaller than the outer perimeter of the CRT.[4,14]
- The display capacity for text input and editing CRTs should be 25-30 lines of text in a single column format with at least 132 characters per line. (Since many printouts have 132 characters per line, and since much of the work on CRTs involve printouts, most CRTs will require the capacity to handle 132 characters per line.)[20]

Section II. PRINTERS

PRINTER

Printers are peripheral units to the central processing unit (CPU). The printer can be located adjacent to the CPU, in a separate printing room, or at the workstation. Printed copy should conform to the guidelines already noted for CRT legibility, particularly for character font and error minimization, character size, and character spacing.

- The printer should print copy at a rate of at least 400 WPM if the user is interacting with the computer through the printer.[17]
- Printer delay should be no more than 1-2 seconds to acknowledge a command if the user is interfacing with the computer through the printer.[20]
- Printer noise level should not be above 75 db. If above this level, the printer should be in an inclosed area separated from personnel.[5]

- A paper advance control or a print head advance should be provided to permit the operator to read the most recently printed line.[21]
- A provision should be made for taking up paper.[21]
- A cutting edge should be provided to remove printed material rapidly and evenly.[21]
- There should be an indication of the remaining paper supply.[21]
- Instructions for reloading paper, ribbon, ink, etc., should appear on an instruction plate attached to the printer.[21]
- Reloading of paper or ribbon should be accomplished without disassembly or using special tools.[21]
- Storage should be provided for supplies such as ribbons, spare paper, ink.[21]
- Paper retainers should be provided to reduce paper vibration.[21]
- Guides should be provided to facilitate accurate positioning of the paper.[21]
- The printer should accept letter size, legal size, computer paper, and all forms that will be used.
- The printing or typing sets should be easily replaceable.[21]
- A print malfunction alarm should be provided to alert the user when requested printing is not being done due to some malfunction. Like other prompts, it should be as specific as possible as to the source of the problem.[21]

Output-paper Qualities

The quality and size of paper used in the printer is an important consideration for system designers in view of the volume produced each day.

- Matte finish paper should be used to avoid smudged copy and glare.[21]
- Hardcopy print should be black characters on a white background to provide maximum contrast.[14,21,22]
- Print should be legible on all required copies.
- Carbon copies should be legible.
- Output on paper which is 8½" × 11" or 8½" × 14" is usually easier to handle than those on standard computer paper (11" × 14").[20]
- Hardcopy records should be available on demand of the user and in the form he desires them.[17]
- Paper in a binder or stapled together may be easier to handle and use than accordian folded paper.[20]
- Production of hardcopy should not itself delay or otherwise change the operation of the overall system.[17]

Output-paper Content

- Information contained on the computer output should be easy to understand and as concise as possible.
- The title of output should be both clear and distinctive.
- Only information needed by the user should be included on the printout. (Extraneous material should be removed.)
- All information needed by user should be on the printout.
- Information should be organized in the order the user will access it.[20]

CLASSIFICATION SYSTEMS: VISUAL AND ACOUSTIC CONFUSIONS

People show consistent tendencies to commit various errors when dealing with strings of random numbers or letters or an alphanumeric mixture. Avoidance of certain letters or numbers and combinations of them will increase accuracy.

Designers of numbering systems or classification systems should observe the following steps:

- Determine the number of unique items to be included in the numbering system
- Determine whether any alphabetic, numeric, or alphanumeric sets will be used as a memorization aid for sub-groups of items.
- Determine the length of the alphabetic, numeric, or alphanumeric sets using the previous decision concerning sub-group aids.
- Specify rules for assigning alphabetic, numeric, or alphanumeric sets to items.
- Designers should eliminate O, I, Z, Y, X, B, and G from an alphanumeric classification system in order to reduce the incidence of letter-digit copying errors.
- In a random letter classification system, in order to reduce letter confusion errors; V, U, Y, Q, and T should not be used.

- If small letters are used, l, o, v, and n should be avoided.
- To avoid letter acoustic confusions, the International Civil Aviation phonetic alphabet can be used (Table 9-2).
- To avoid number confusions the following pronounciation guide in Table 9-3 should be used.[21,24,25]

Table 9-2. Phonetic Alphabet.

Letter	*Word*	*Pronunciation*
A	ALFA	*AL* FAH
B	BRAVO	*BRAH* VOH
C	CHARLIE	*CHAR* LEE
D	DELTA	*DELL* TAH
E	ECHO	*ECK* OH
F	FOXTROT	*FOKS* TROT
G	GOLF	GOLF
H	HOTEL	HO *TELL*
I	INDIA	*IN* DEE AH
J	JULIET	*JEW* LEE ETT
K	KILO	*KEY* LOH
L	LIMA	*LEE*MAH
M	MIKE	MIKE
N	NOVEMBER	NO *VEM* BER
O	OSCAR	*OSS* CAH
P	PAPA	PAH *PAH*
Q	QUEBEC	*KEH*BECK
R	ROMEO	*ROW* ME OH
S	SIERRA	SEE *AIR* RAH
T	TANGO	*TANG* GO
U	UNIFORM	*YOU* NEE FORM
V	VICTOR	*VIK* TAH
W	WHISKEY	*WISS* KEY
X	XRAY	*ECKS* RAY
Y	YANKEE	YAN KEE
Z	ZULU	*ZEW* LEW

Table 9-3. Numerical Pronunciation.

a. To distinguish numerals from words similarly pronounced, the *proword "FIGURES"* should be used preceding such numbers.

b. When numerals are transmitted by radio telephone, the following rules for their pronunciation should be observed:

NUMERAL	*SPOKEN AS*
0	*ZE*-RO
1	WUN
2	TOO
3	TREE
4	*FOW*ER
5	FIFE
6	SIX
7	*SEV*-EN
8	AIT
9	*NIN*-ER

c. Numbers should be transmitted digit by digit except that exact multiples of thousands may be spoken as such. However, there are special cases, such as anti-air warfare reporting procedures, where the normal pronunciation of numerals is prescribed; for example, 17 would then be "seventeen".

	NUMERAL	*SPOKEN AS*
	44	*FOW*-ER *FOW*-ER
	99	*NIN*-ER *NIN*-ER
	136	WUN TREE SIX
	500	FIFE *ZE*-RO *ZE*-RO
Time	1200	TIME WUN TWO *ZE*-RO *ZE*-RO
	1478	WUN *FOW*-ER *SEV*-EN AIT
	7000	*SEV*-EN *THU*-SAND

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CHAPTER 9 CHECKLIST

	Yes	Not applicable	Not known *	no *
LEGIBILITY				
1. Is the luminance level of the display background 5 Footlamberts (fL)?	☐	☐	☐	☐
2. Is the luminance level for the characters on the CRT adjustable in a range including 50fL or fixed at 50fL?	☐	☐	☐	☐
3. Are the luminance ranges of surfaces immediately adjacent to the display between 10 percent and 100 percent of screen background luminance?	☐	☐	☐	☐
4. Are all light sources except emergency indicators less bright than the display characters?	☐	☐	☐	☐
5. Is the contrast between the characters on the display and the background of the display 90 percent?	☐	☐	☐	☐
6. Does the display have bright characters on a dark background?	☐	☐	☐	☐
7. Can the user reverse to dark characters on a bright background?	☐	☐	☐	☐
CHARACTER GENERATION				
8. Are the characters on the display generated by dot matrix at least 5 × 7?	☐	☐	☐	☐
9. If a font is used, are the characters based on the Lincoln/Mitre (L/M) font?	☐	☐	☐	☐
10. Does the display have both upper and lower case letters?	☐	☐	☐	☐
11. Does the letter *A* have a clearly delineated space above the horizontal stroke?	☐	☐	☐	☐
12. Does the letter *B* have approximately equal loops at the top and bottom?	☐	☐	☐	☐
13. Are the letters *C*, *G*, and *O* sufficiently differentiated?	☐	☐	☐	☐
14. Are the horizontal strokes of the letter *E* equally separated?	☐	☐	☐	☐
15. Is the center section of the letters *M* and *W* sufficiently long?	☐	☐	☐	☐
16. Does the letter *P* have a loop half way down the line?	☐	☐	☐	☐
17. Are the letter *S* and the number *5* sufficiently differentiated from each other?	☐	☐	☐	☐
18. Are the letter *I* and the number *1* easily discriminated?	☐	☐	☐	☐
19. Are the letters *U* and *V* easily discriminated?	☐	☐	☐	☐
20. Are the letters *Y* and *T* easily discriminated?	☐	☐	☐	☐
21. Are the numbers *6* and *9* easily recognizable?	☐	☐	☐	☐

	Yes	Not applicable	Not known*	no*
22. Is the minimum character height 0.156 inches (3.96mm) on the display?	☐	☐	☐	☐
23. Is the maximum height 0.2 inches (4.5mm)?	☐	☐	☐	☐
24. Is the width-to-height ratio between 2/3 to 4/5?	☐	☐	☐	☐
25. Is the stroke-to-height ratio between 1/9 to 1/5?	☐	☐	☐	☐
26. Is the minimum number of raster lines 10-12?	☐	☐	☐	☐
27. Is the character spacing between individual characters between 20 percent and 50 percent of the character width?	☐	☐	☐	☐
28. Is the spacing between words proportional to character spacing?	☐	☐	☐	☐
29. Is the interline spacing on the display between 100 percent to 150 percent of the character height so the ascenders (superscripts) and descenders (subscripts) do not intrude into the characters above or below the line?	☐	☐	☐	☐
30. Is there sufficient space so that adjacent ascenders and descenders do not overlap or intersect?	☐	☐	☐	☐
31. Is the display screen free from flicker?	☐	☐	☐	☐
32. Are all areas of the display surface legible at least 30 degrees from the normal viewing angle?	☐	☐	☐	☐
33. Is the screen angle nearly perpendicular to the viewer's line of sight, but placed so that reflection from overhead lighting is avoided?	☐	☐	☐	☐
34. Is the viewing angle adjustable?	☐	☐	☐	☐
35. Is the size of the display at least 12 inches (30.48cm)?	☐	☐	☐	☐
36. Is the size of the usable display area (area of surface where information and data are displayed) smaller than the outer perimeter of the CRT?	☐	☐	☐	☐
37. Is the display capacity for text input and editing CRT's 25-30 lines of text in a single column format with at least 132 characters per line?	☐	☐	☐	☐
PRINTER				
38. Does the printer conform to the guidelines already noted for CRT legibility: e.g., character size, character spacing?	☐	☐	☐	☐
39. If the user is interacting with the computer through the printer, does it print at least 400 words per minute?	☐	☐	☐	☐
40. Is the printer delay less than 1-2 seconds for acknowledging a command if the user is interacting with the computer through the terminal?	☐	☐	☐	☐
41. Is the printer noise level below 75db?	☐	☐	☐	☐
If no, is the printer in an enclosed area separated from personnel?	☐	☐	☐	☐
42. Is a paper advance control provided?	☐	☐	☐	☐
43. Is a paper take-up device provided?	☐	☐	☐	☐

	Yes	Not applicable	Not known*	no*
44. Is a cutting edge provided?	☐	☐	☐	☐
45. Is there an indication of the remaining paper supply?	☐	☐	☐	☐
46. Do instructions for reloading paper, ribbon, ink, etc., appear on the instruction plate attached to the printer?	☐	☐	☐	☐
47. Are the reloading of paper or ribbons accomplished without disassembly or using special tools?	☐	☐	☐	☐
48. Are storage facilities provided for supplies such as ribbons, spare paper, ink?	☐	☐	☐	☐
49. Is a paper retainer provided to reduce paper vibration?	☐	☐	☐	☐
50. Are guides provided which facilitate accurate positioning of paper?	☐	☐	☐	☐
51. Does the printer accept letter size, legal size, computer paper, and all the forms that will be used?	☐	☐	☐	☐
52. Are printing or typing (e.g., ball, daisy wheel) sets easily replaceable?	☐	☐	☐	☐
53. Are there printing malfunction alarms?	☐	☐	☐	☐
OUTPUT-PAPER CONTENT				
54. Is the information contained on the computer output easy to understand and concise?	☐	☐	☐	☐
55. Is the title of the output clear and distinctive?	☐	☐	☐	☐
56. Is all the information the user needs on the printout?	☐	☐	☐	☐
57. Has all unnecessary or extraneous information been removed?	☐	☐	☐	☐
58. Is the information organized in the order that the user will access it?	☐	☐	☐	☐
59. Does the computer perform sub-totals, add columns, sort data, and other tasks in which it is more efficient than humans?	☐	☐	☐	☐
60. Are adequate spaces left between fields so that they are easily differentiated?	☐	☐	☐	☐
OUTPUT-PAPER QUALITIES				
61. Is the output paper a matte type finish to reduce smudging and glare?	☐	☐	☐	☐
62. Does the hardcopy have black characters on a white background?	☐	☐	☐	☐
63. Is the print legible on all copies?	☐	☐	☐	☐
64. Are hardcopy records available on demand of the user?	☐	☐	☐	☐
65. Are they in the desired form?	☐	☐	☐	☐
66. Is the hardcopy paper bound or stapled for storage?	☐	☐	☐	☐
67. Does the production of hardcopy delay or otherwise change the operation of the overall system?	☐	☐	☐	☐

* Answers in these two columns require some action to obtain information or justify departing from the guidelines.

System Designer
Signature: _____ Date: _____

Approved by: _____ Date: _____

User acceptance: _____ Date: _____

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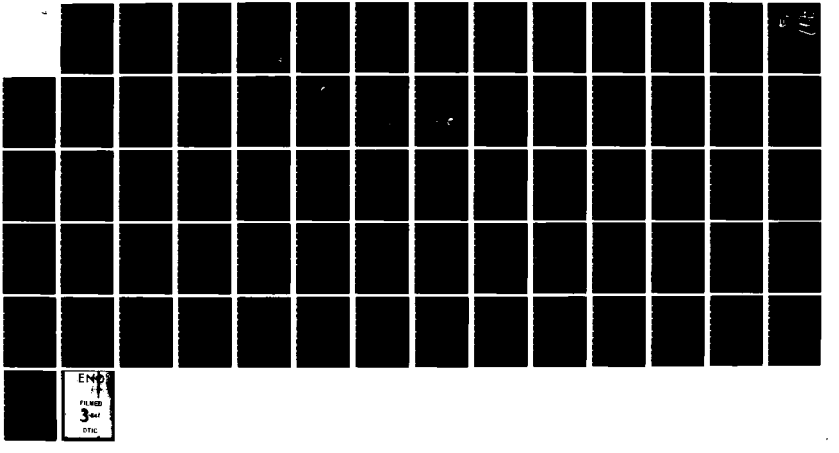

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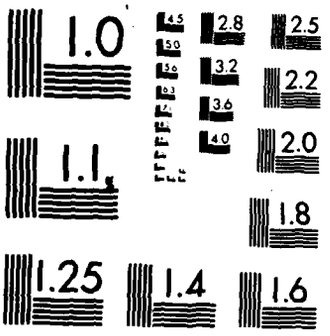

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CHAPTER 10
WORK STATIONS

The purposes of this chapter are to:

- ***Identify office environment factors that may reduce user efficiency and effectiveness.***
- ***Suggest guidelines that will result in a more acceptable office environment and suitable office aids.***

INTRODUCTION

Although the human factors specialist, the system managers, or the system procurers, may not have much control over design of the immediate workstation, the office, or the larger environment in which the system is placed, it MUST be acknowledged that factors within these environments can affect the performance of a user. The user's performance will degrade if noise, temperature, lighting, reach envelopes, etc., exceed certain ranges.

These suggestions may elicit the reaction, why are the MIS users different from other personnel? They are not. Present working environments commonly are used as a model. We suggest examining the benefits and limitations of current practices before adopting them. Even though there is not much empirical research which provides unequivocable answers, there are some studies and observations that are relevant. These guidelines may apply to other personnel and their work environments, but the focus is on the computer-human interface. We propose minimizing the negative effects on performance due to the work station, office, and environment.

This chapter adopts the conceptualization that there are expanding spheres in which a person operates (see Figures 10-1 and 10-2). One could start with analyzing the reach envelope of the user, when working at their desk with an MIS product, at a microfiche reader, or at a CRT. The next level of analysis concerns the layout of the personal office space. This may include the relative positions and adequacy of the desk, typing table, cabinet, table space, lighting, etc. The next level to be considered could be the combination of personnel spaces which form a branch, division, and office. Human factors should be considered in building design, building location, etc.; however, these areas will not be considered in these guidelines.[1]

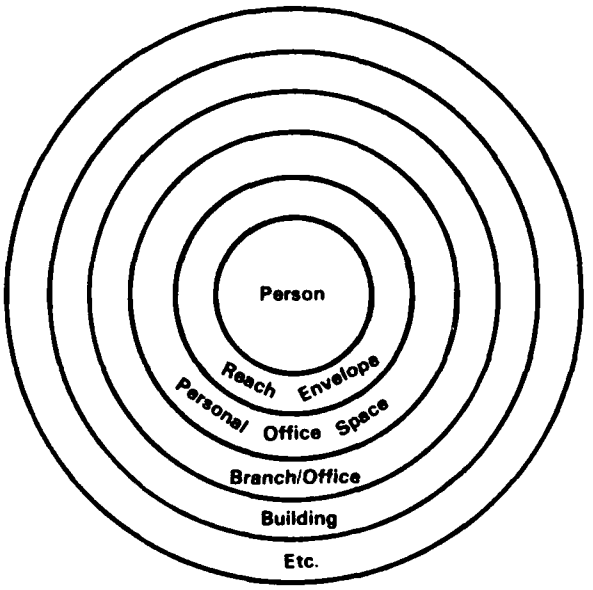


Figure 10-1. Expanding levels of the environment impacting on personnel performance.

GENERAL GUIDELINES*

An Effective Office

In general, there is insufficient data to recommend between a private, semi-private, or an open office. Each type of office has its advantages and disadvantages. The following general guidelines pertain to all types of offices.

Design

- Office location should be determined on the basis of functions, communication patterns, and the needs and the convenience of staff members, customers, support personnel, housekeeping, and service personnel. Priority should be given to co-locating personnel who have a need for frequent face-to-face contact.

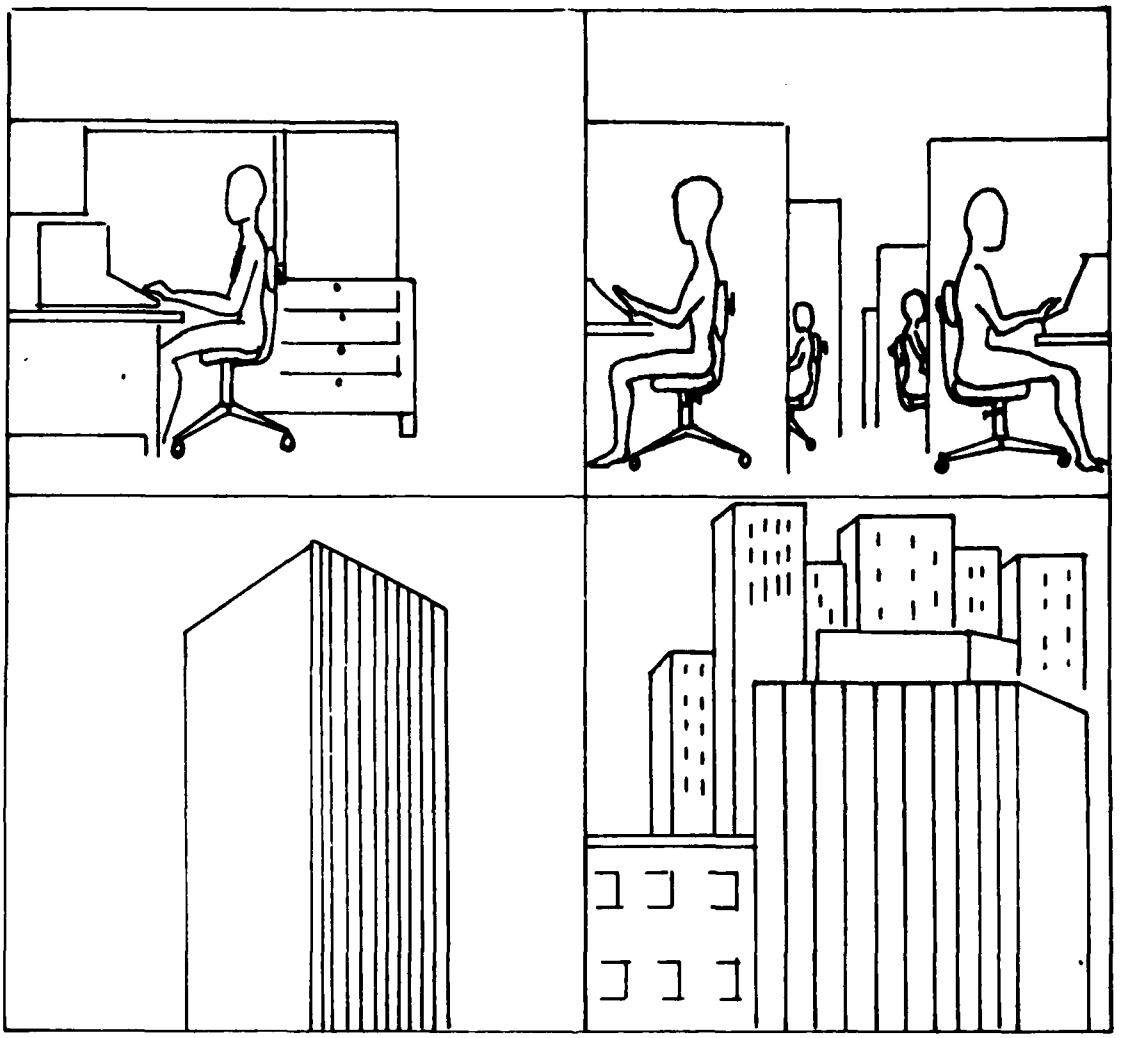


Figure 10-2. Various levels of man-environment.

- Commonly used facilities such as libraries, copy services, and rest rooms should be centrally located. This also applies to office entrance and exit locations.
- Walls or partitions should not be used to separate workers who must share items of equipment on a regular basis.
- Noisy equipment (e.g., copiers, sorters) should not be located in the same work area with workers who need the equipment only infrequently.
- The office space should be organized so that there are clearly recognizable pathways.

General Support Items

Most offices require the following:

1. Electric outlets
2. Telephone outlets
3. Terminal lines or outlets
4. General materials storage (coats, umbrellas, etc.)
5. Housekeeping equipment storage
6. Office materials storage (books, papers, files)
7. Chairs
8. Desks, stands, tables (both for writing and drawing and support surfaces for CRT's, typewriters, paperwork, telephones, etc.)

9. Lights (both task and overhead ambient)
10. Vents for heating and cooling
11. Security systems, alarms, fire extinguishers, etc.
12. Drinking fountain, restrooms

Environmental Controls

Good lighting and a comfortable temperature are prerequisites of efficient office work. Refer to the sections on environmental control and on lighting. Lighting, temperature control, as well as acoustic control, should be a part of the office facility planning.

Facilities for the Handicapped

Offices should be designed so that they can be occupied by either handicapped workers or handicapped clients. Each office should be examined to remove those barriers which make it either difficult or impossible for a handicapped person to enter or use the office. The principal considerations are the following:

1. Doorways and hallways wide enough to accommodate wheelchairs.
2. Ramps and elevators
3. Tactile cues for the blind, for example on elevator controls
4. Special rest-room fixtures
5. Special furniture to accommodate wheelchairs

Office Identification and Signs

Proper office identification and signing are very important. The signing scheme should be both useful and attractive.

The Private/Semi-Private Office

Where professional or supervisory counseling or confidential discussions are a regular occurrence, a private office is required. Daily activity logs or observations should be kept to determine whether private offices are required.

The main advantages of this type of office is that it provides a relatively quiet environment separated from all the noise and distractions that can occur in an open office. The possible drawbacks are that walls take up floor space, supervision may be more difficult, employees may feel isolated, and walls are difficult to move to accommodate changes in company structure and space allocation.

- The smallest acceptable private office space should be approximately 7.5 x 7.5 ft. (2.3 x 2.3m). This can accommodate a desk and one side chair with minimal space for storage of equipment and materials.
- Each office should have good general lighting. The ceiling and walls, in general, should be painted a light color to provide adequate light distribution.
- The ventilation system should be designed so that independent control can be accomplished within the office even when the door is shut.
- A general temperature-sensing control for a suite of offices should not be placed in only one office.

The "Landscaped" Office

The main characteristic of a landscaped office is its flexibility. Office space is planned and designed around the organizational process with the recognition that these processes or components frequently change. The office space is made adaptable — that is, the office space can easily be changed as the organization changes. The main problems are noise, a lack of privacy, and the creation of a disordered maze.

The landscaped office concept can be accomplished through the use of special furnishings such as movable partitions.

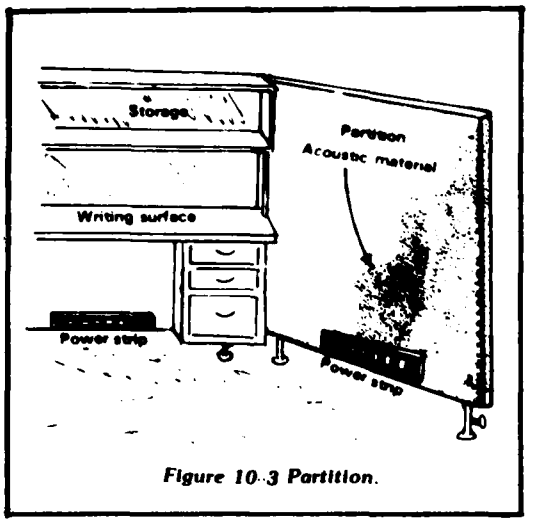


Figure 10-3 Partition.

It is desirable (even when using a curved partition system) to retain a certain amount of pathway continuity. It is particularly important not to create unnecessary deadends. These can be confusing to the person who is trying to locate someone, and also may be a safety hazard in the event of the need for an emergency departure from the area.

Misuse of partitions can result in chaos with workers scattered in a random fashion, rather than systematically organized in the available space. The result has been to confuse many workers and visitors by the lack of aisles, signs, or clear visual demarcations.

In designing or selecting a modular partitioning or furniture system, priority should be given to a system having the following characteristics: is sturdy, does not have "feet" tripping hazards, provides for acoustic control, wears well, is easily assembled and disassembled, and can be cleaned.

In many offices, a major problem is lack of space. Open offices also require some minimum amount of space per employee. Although a change from a bullpen to a landscaped design may be intended to improve the conditions and morale of the employees, such a change may, in fact, worsen the morale of the employees if the basic problems associated with overcrowding are not resolved. The employees may consider the expense of the office landscaping a poor decision because all that has happened is that they are forced to adapt to the same problems in a slightly different form.

CRITICAL FACTORS IN WORKPLACE DESIGN

In today's computerized society, workstations are constantly undergoing change — change brought about by new equipment configuration, or additional equipment made necessary by changes in job responsibilities. Usually, such changes are not pre-planned, but are of the "make do" variety. Proper planning and design, however, can assure an efficient workplace and lead to increased productivity. The following guidelines emphasize the importance of tailoring both space and equipment to the physical limitations of the employee.

- Adequate space should be provided for work involving large computer printouts and necessary reference documentation (fig 10-4).[1]
- The workstation and associated job aids should be adjustable to accommodate comfortably the expected physical dimension ranges of the user population (usually the 5th to the 95th percentile of the adult population is used as the standard) (fig 10-5).[1,3,4]
- All of the equipment workers must use to do their job should be located in the immediate area to insure maximum use.[1]
- Even though security concerns may require isolating a terminal, avoid placing it in a small unattractive room.
- Proper eye position relative to the viewing tasks (i.e., keyboard-to-CRT, keyboard-to-control console, etc.) should be provided. Figure 10-6 gives a graphic representation of eye position.[4]
- Design should include the reach "envelope" of the arms and legs (i.e., the user in most cases should be able to reach the controls without having to stretch or change positions). Figure 10-7 illustrates the reach envelope.[5]
- The workstation should be adjustable so that the home keys on the keyboard are at 2 inches (50mm) below the elbow height. This is the optimum work height for typing.[6]
- Every task should be structured in a way that allows the employee to change positions regularly. Failure to permit postural changes will result

Figure 10-4. CRT-printer workstation with work surfaces and storage facilities.

Next page 10-7

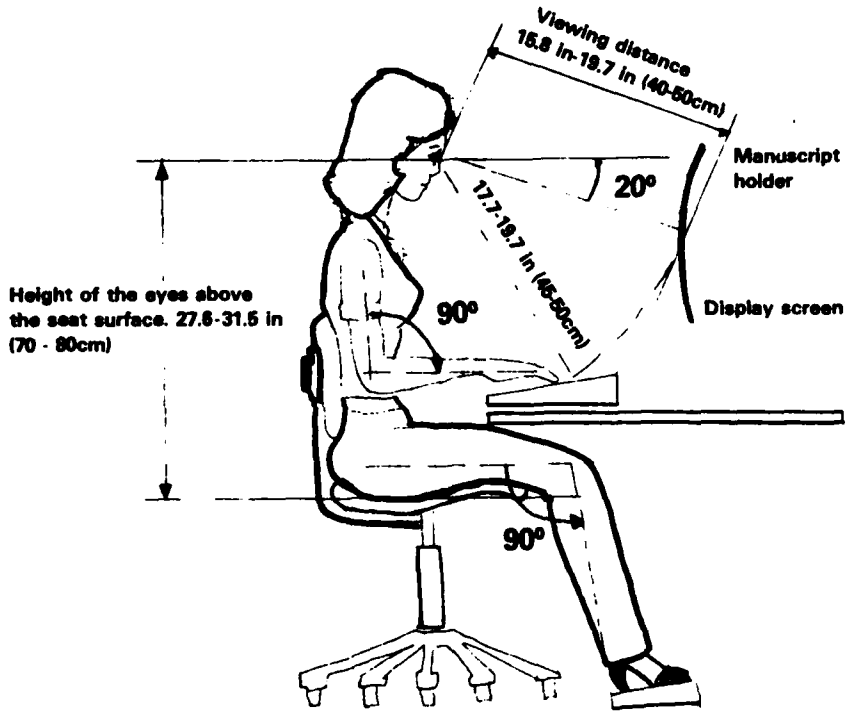


Figure 10-6. Viewing considerations.

in fatigue due to the static load on the muscles (fig 10-8).[4]

- Office personnel should be given a short training session on how to adjust the office equipment to obtain a physiologically sound, comfortable position.[4]

NOISE LEVELS[3]

General Workspaces

Areas requiring occasional telephone use or occasional direct communication at distances up to 5 ft (1.5m) should not exceed 75 db(A) or 57 dB PSIL-4 or 68 dB PSIL.[3]

Operational Areas

Areas requiring frequent telephone use or frequent direct communication at distances up to 5 ft (1.5m) should not exceed 65 dB(A), or 57 dB PSIL-4 or 58 dB PSIL. (Examples: operation centers, mobile command and communication shelters, combat information centers, word processing centers.)[3]

Large Workspaces

Areas requiring no difficulty with telephone use or requiring occasional direct communication at distances up to 15 ft (4.570m) should not exceed 55 dB(A) or 47 dB PSIL-4 or 48 dB PSIL.[3]

Small Office Spaces/Special Areas

Areas requiring no difficulty with direct communication should not exceed 45 dB(A) or 37 dB PSIL-4 or 38 dB PSIL. (Example: conference rooms, libraries, offices, command and control centers.) A further breakdown of noise requirements of an office can be seen in Table 10-1.[3]

Quiet Areas

Areas requiring extreme quiet should not exceed 35 dB(A) or 27 dB PSIL-4 or 28 dB PSIL.[3]

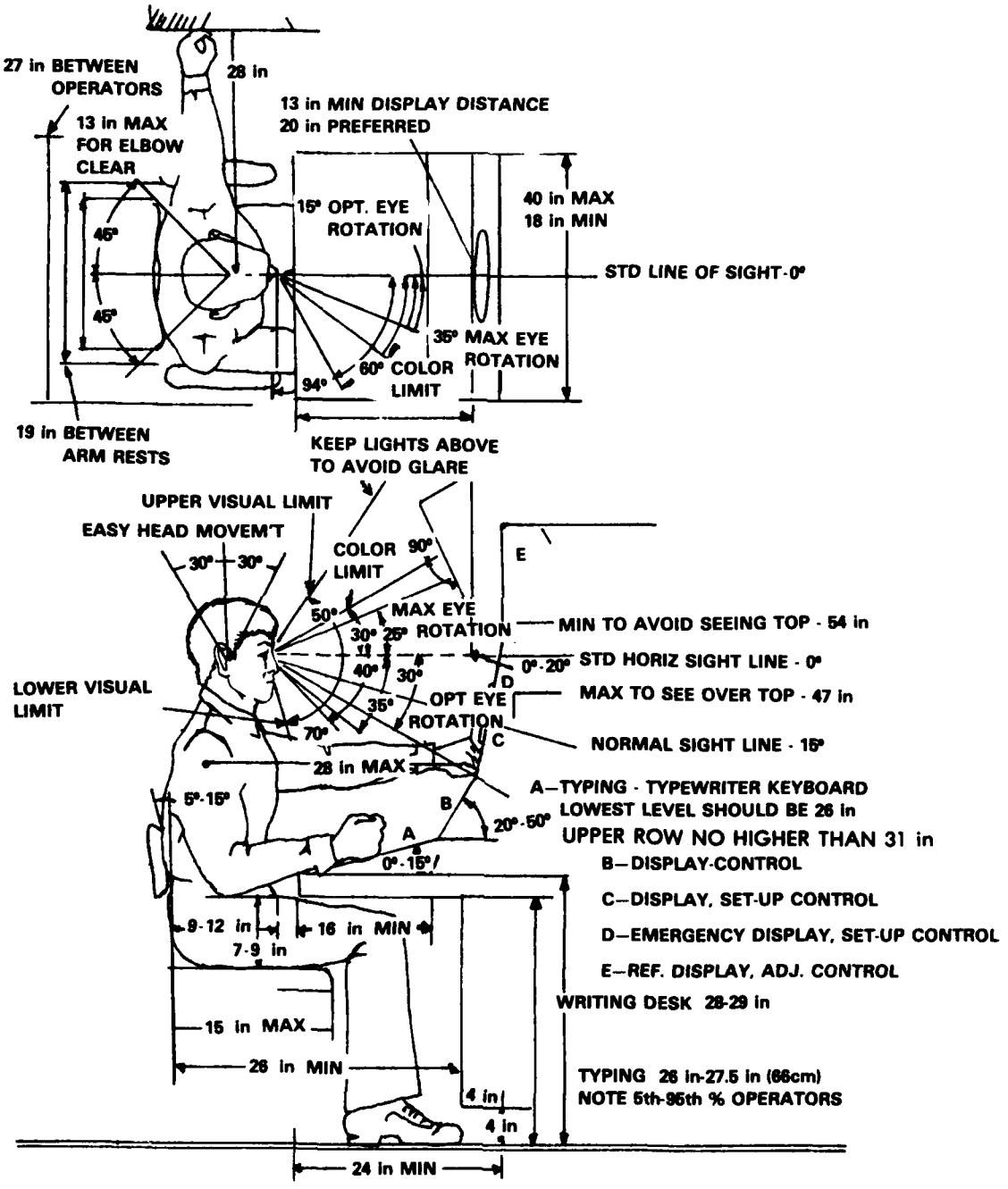


Figure 10-7. Suggested parameters for mockup of a seated operator console (VanCott & Kinkade, 1972).

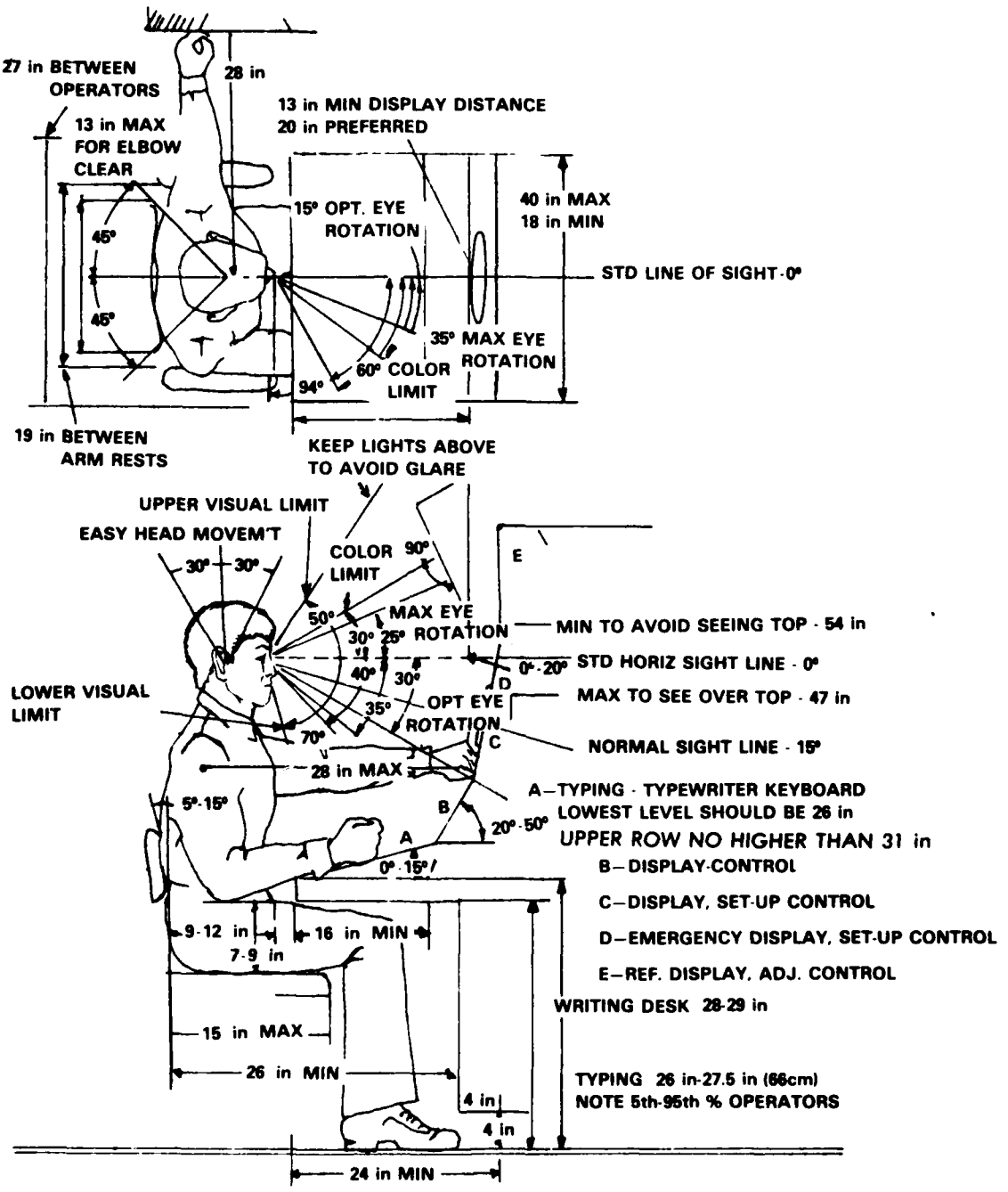


Figure 10-7. Suggested parameters for mockup of a seated operator console (VanCott & Kinkade, 1972).

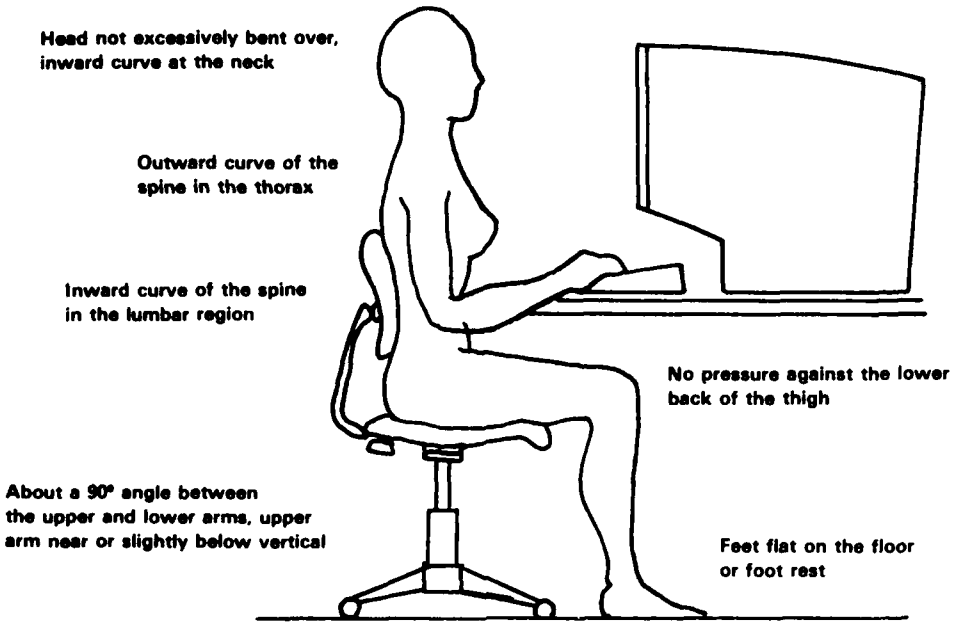


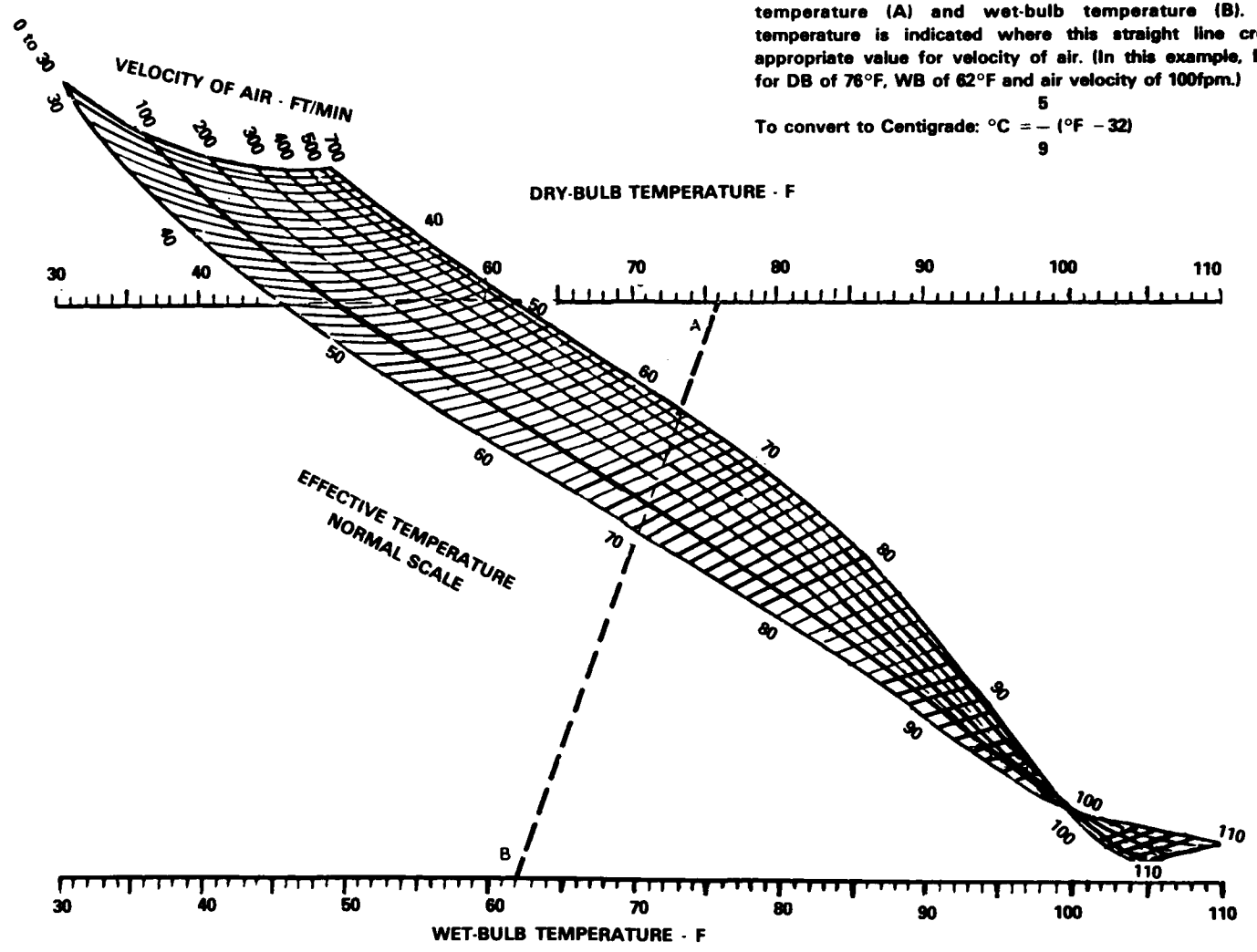
Figure 10-8. The main characteristics of a favorable seating posture when working with a CRT. Although this posture may be considered correct in the ergonomic sense, it should be borne in mind that the human body is better adapted to movement than to maintaining static positions. Any static posture, even the 'ideal', soon becomes fatiguing if it has to be maintained for too long a period.

Table 10-1. Noise criteria (acoustical) for offices[7]

NCA	*Communication Environment*
20 to 30	Very quiet office, telephone use satisfactory, suitable for large conferences.
30 to 35	Quiet office, satisfactory conferences at 15-ft table, normal-voice range 10-30 ft, telephone use satisfactory.
35 to 40	SATISFACTORY for conferences at 4-5 ft table, telephone use slightly difficult, normal-voice range 3-6 ft, raised-voice range 6-12 ft.
50 to 55	UNSATISFACTORY for conferences of more than two or three people, telephone use slightly difficult, normal-voice range 1-2 ft, raised-voice range 3-6 ft.
55 to 60	Very noisy office, telephone use difficult.
60 to 70	Raised-voice range 1-2 ft, telephone use difficult.
70 to 80	Raised-voice range 1-2 ft, shouting range 3-6 ft, telephone use very difficult.
Above 80	Communication extremely difficult, telephone use unsatisfactory.

NOTE: To use nomograph, draw straight line between dry-bulb temperature (A) and wet-bulb temperature (B). Effective temperature is indicated where this straight line crosses the appropriate value for velocity of air. (In this example, ET is 69°F for DB of 76°F, WB of 62°F and air velocity of 100fpm.)

To convert to Centigrade: $°C = \frac{5}{9}(°F - 32)$



Clothing: Customary indoor clothing

Activity; Sedentary or light muscular work.

Heating Methods: Convection type, i.e., warm air, direct steam or hot water radiators, plenum systems.

Figured 10-9. Effective temperature.

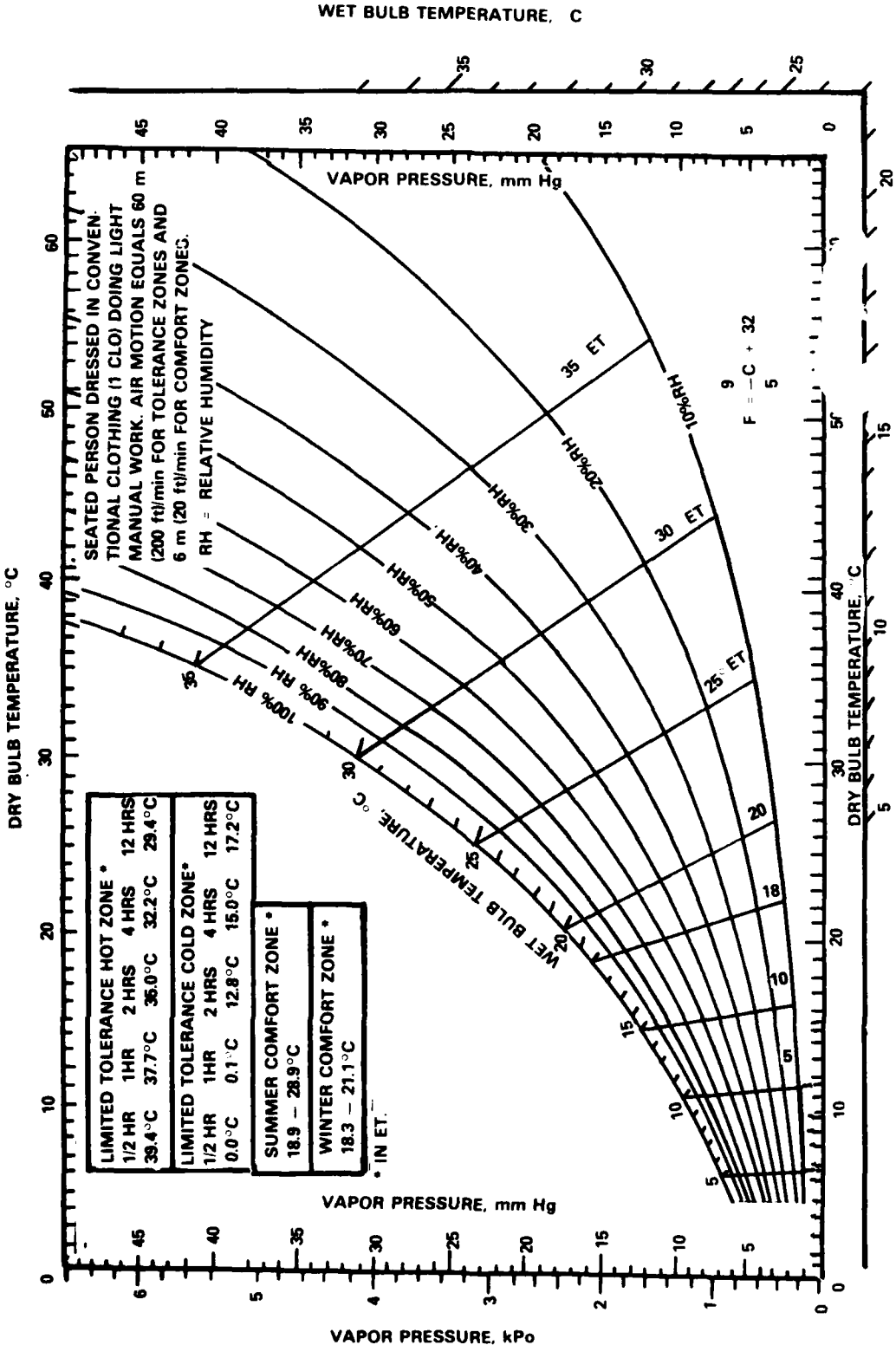


Figure 10-10. Summer and winter comfort zones and thermal tolerance for inhabited compartments.

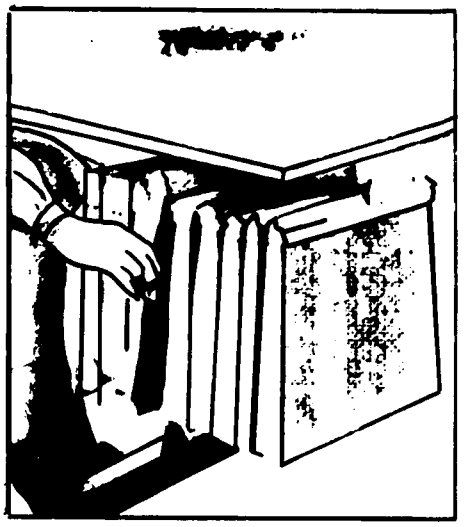


Figure 10-11a. Storage at the workstation.

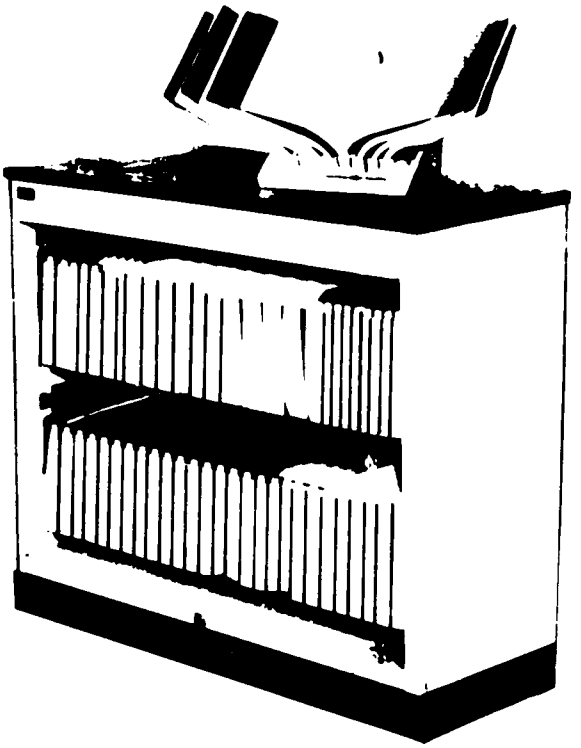


Figure 10-11b. An example of printout storage.

Allow for expansion.

Allow ease of locating, removing, and replacing stored materials.

Permit easy access. (Excessive physical strain or awkward body positions should not be necessary.)[1]

- Space should be provided for personal items such as coats, purses, etc.[1]

Desk or Table Height

- Desk and table height should be adjustable.
- Desk height should be 28 to 29 inches high (711-737mm) when not adjustable.
- If the desk is intended to be used with a keyboard on it, it should be between 26 inches to 27.5 inches (550mm to 699mm).
- It is important both physiologically and for perceived comfort that the forearms of the employees be horizontal to the work station, whether desk top, or home row of the keyboard.[4,10,11]

Work Surface Dimensions

- The worker must be provided with adequate desk space — if not at his own desk, then at a work table nearby. At least 30 inches (762mm) would be needed to place two 15 inches (381mm) wide printouts side by side on a tabletop, and 23 inches (584mm) in depth if the printouts were of the accordion-fold type and opened.
- The minimum work surface width for consoles that must be provided is 15 inches (381mm), which should allow room for placement of a printout next to the terminal, though not necessarily on the typist's preferred side.[9,12]
- Storage areas should include a buffer space for both incoming and completed work. The size of such an area will vary according to the individual's task.

RECOMMENDED CHAIR DIMENSIONS

Seat Height

- The user should be able to adjust the height of the seat pan between 15 and 20 inches (405-508mm) in increments of 1 inch (25mm) (fig 10-12).[3,4,9,13,14,15,16,17]
- The depth of the seat pan should be between 12-15 inches (304-381mm).[4,9,11,16]

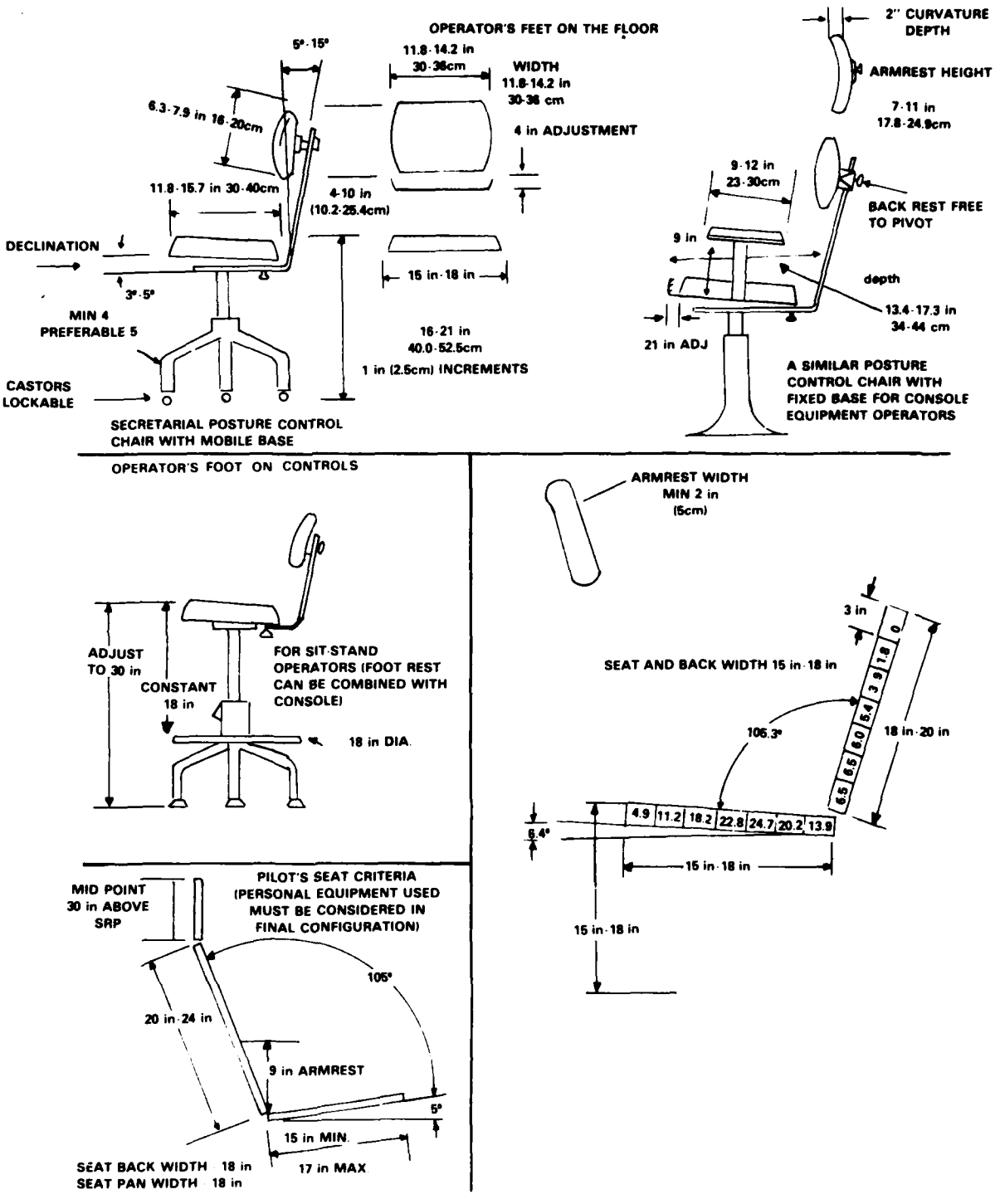


Figure 10-12. Typical dimensions for common seat configuration.

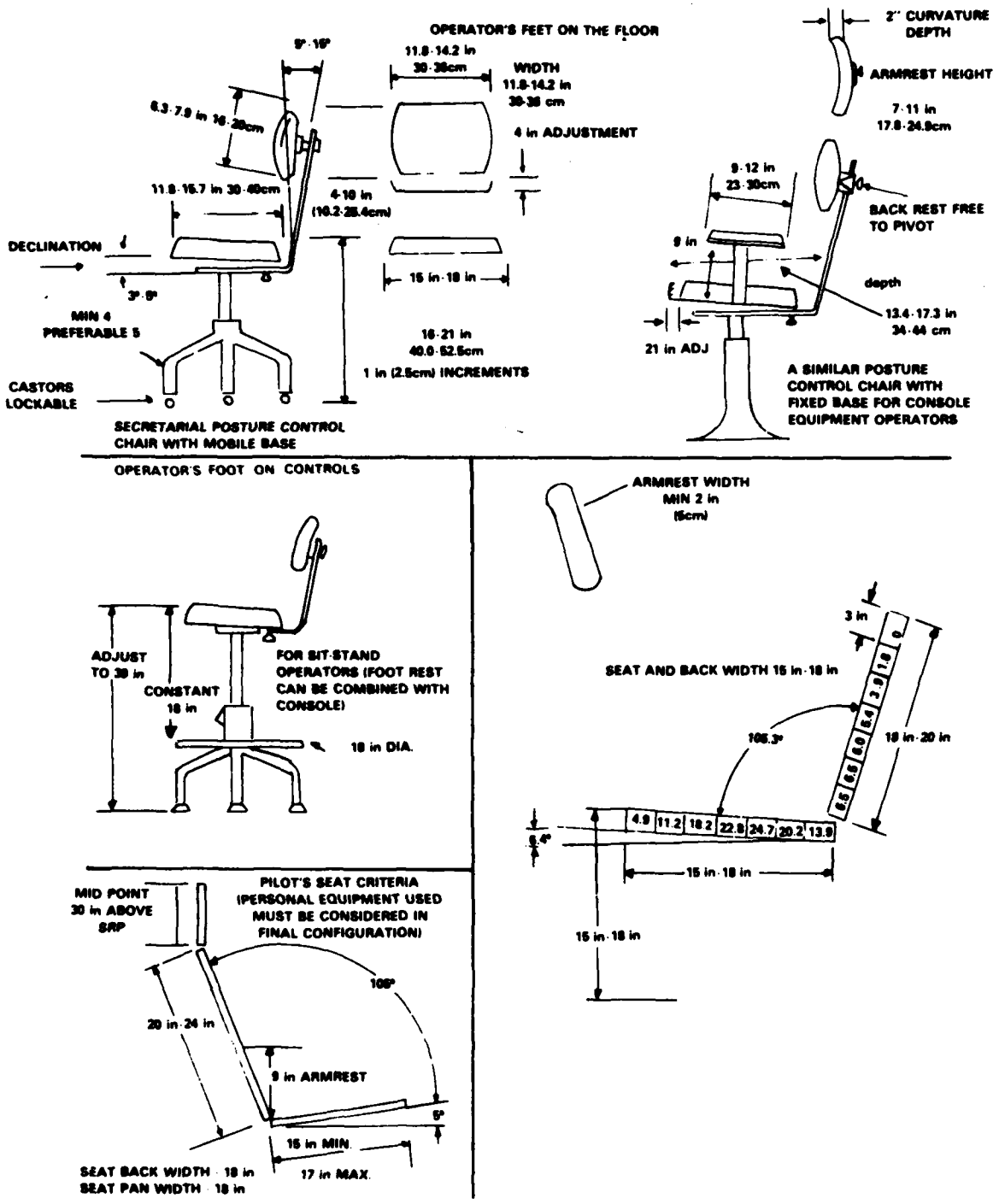


Figure 10-12. Typical dimensions for common seat configuration.

- The seat pan should be flat, with the front edge rounded to prevent pressure on the back of the legs. A slight rearward declination between 3 degrees and 5 degrees is preferable in order to keep the trunk against the backrest and to prevent sliding.[13 17 18 19]
- The width of the seat should be large enough to accommodate larger users, as well as to allow for changes in position. The seat should be a minimum of 15.7 inches (400mm) wide.[9 11 16 20]
- A seat should not be uncomfortable, nor interfere with the user's ability to change positions. The upholstery should be flat and stiff, only giving way 1 inch (25mm), and constructed of a porous material, such as cloth.[9 16]

Backrest

- To be effective, the backrest should engage the lumbar region of the back; therefore, it must be adjustable both in height and in depth from the seat edge.
- The backrest should be small enough vertically that it does not interfere with movements of the shoulders and arms when the tasks require such movement (i.e., keyboarding).
- The backrest should slope backward in order to support more of the body's weight.
- The backrest should be slightly concave toward the sitting individual. In the side view, it should look slightly convex. The edges of the backrest should be rounded, and it should be slightly padded and upholstered.
- The space between the seat pan and the backrest should be adjustable between 4-10 inches (105-254mm).
- The backrest should be between 6.3-7.9 inches (160-200mm) and between 11.8-14.2 inches (300-360mm) wide.
- The backrest should be adjustable in depth from the front edge of the seat. The adjustment should be between 13.4-17.3 inches (340-440mm).[9 11 14 16 17]

Backrest Angle

The backrest angle is important in helping to support the body's weight, and to keep pressure off the lower back. In general, the greater the angle (max 45 degrees), the more relaxing the chair. For office chairs the angle of the backrest should swivel between 5 degrees and 15 degrees from the vertical.[5 10 12 17]

Armrest

The height of the armrests should be adjustable to fit the user's needs. To fit a large segment of the population, the arm rests should be adjustable between 7-11 inches (178-279mm).

- The length of the armrest should be sufficient to provide support for the user's arm but not interfere with the mobility of the user. The recommended length of the armrests is between 9-12 inches (229-305mm).
- The armrests should be cushioned with the same amount and type of padding as the seat and the backrest.

The chair must be sturdy and resistant to tipping (i.e., the base must have at least four-legs, and preferably a five-leg pedestal.

Castors, when desired, should be equipped with locks to prevent unwanted chair movement.[9 10 11 12 21 22]

Footrest

- The footrest can be a vital component of the work site under certain conditions. The actual height of the footrest depends on where it is used, chair height, leg length, etc.
- To accommodate a range of people, both the height and the angle of inclination of the footrest should be adjustable.
- The height should be adjustable in a range of 0 to 4 inches (0-99mm) from the standard height and the angle of inclination between 0 degrees and 30 degrees.
- A heel stop should be added to adjustable slope footrests.[16 23]

CLEARANCES

Height

- The minimum leg room height as measured from floor to footrest to the underside of the desk or table is 25 inches (635mm).

Depth

- The minimum allowable knee room (depth) as measured from the beginning of the desk to the front of the knees at knee level is 16 inches (406mm). A minimum of 24 inches (610mm) of leg room depth must be provided if the user is to be able to stretch his legs. If it is possible to provide more space than these minimums, it should be done.[9 11 12]

Width

- The very minimum allowable width for leg room is 20 inches (508mm).[10,12,13]

If these minimum leg room dimensions cannot be met, the workspace must be designed for the standing operator.

Thigh

The minimum clearance between the seat of the chair and the underside of a desk or table is 7 inches (178mm).[9,11,24]

- When possible allow more than 7 inches of thigh clearance.

KEYBOARDS

Working Level

Working level is defined as the distance between the underside of the thighs and the palms of the hands when operating a keyboard with the hands and forearms in an approximately horizontal position.

- The ideal working level is between 8.7-9.8 inches (220-250mm) (fig 10-13a). That is 1-3 inches (25.4-76.2mm) below elbow height. An uncomfortable working level is shown in Figure 10-13b.[4,6]
- To achieve the ideal working level, it may be necessary to set the keyboard into the desktop. However, this is only feasible when the keyboard is detachable from the CRT screen. If not, the CRT screen will be in too low a position to permit comfortable viewing.[4]

Position on Work Surface

- The height of the home row of keys above the floor should be between 28.4 and 29.5 inches (720-750mm).
- The distance between the front edge of the desk

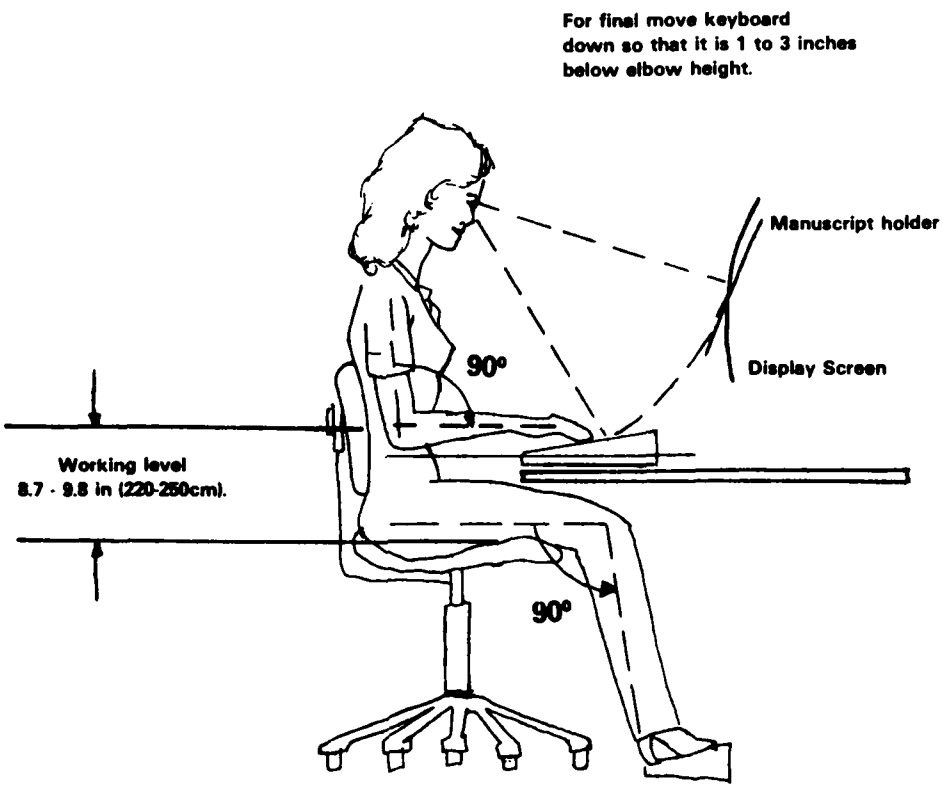


Figure 10-13a. The ideal working level is defined as the distance between the underside of the thighs and the palms of the hands when operating the keyboard with the hands and forearms in an approximately horizontal position. The optimal fine motor working level is 1 to 3 inches (25 to 76mm) below elbow height.

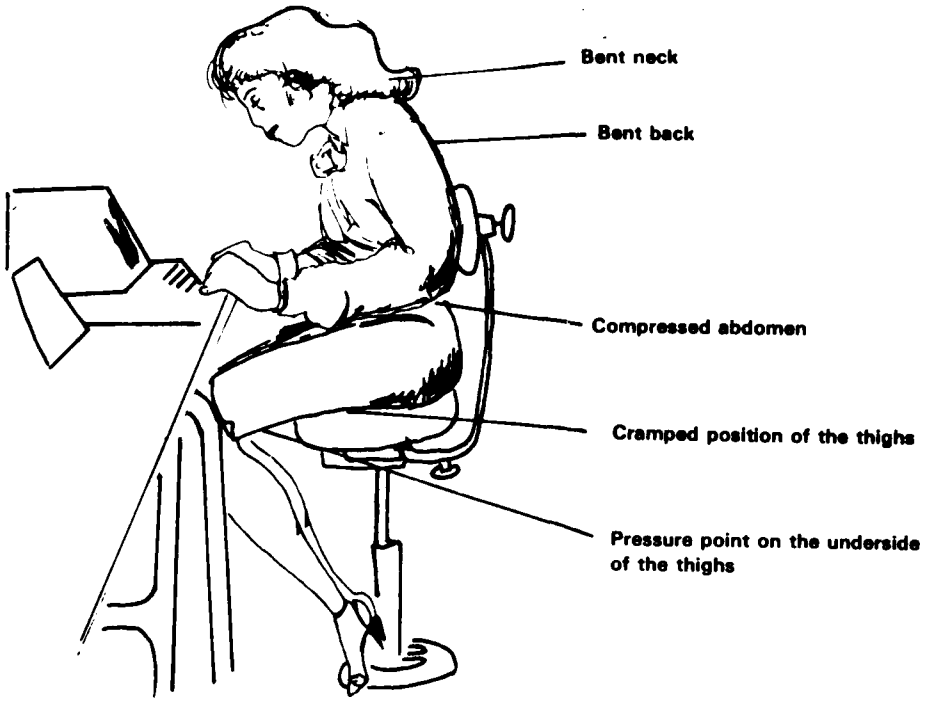


Figure 10-13b. An example of common physical complaints associated with a poorly designed workspace.

and the back row of keys should be no more than 15.7 inches (400mm).

- Allowance for a "free area" of approximately 2.4 inches (60mm) depth in front of the keyboard. This area can be used as a rest for the heels of the operator's hands.[4,9]

Placement of CRT in Relation to User

- The recommended viewing distance to the CRT screen is between 15.8 inches and 19.7 inches (400-500mm). The viewing distance to the CRT screen should not be greater than 27.6 inches (700mm).[4]
- The viewing distance to the keyboard should be between 17.7-19.7 inches (450-500mm).[4]
- Keep the viewing distance difference to the CRT and the keyboard as small as possible to reduce strain caused by a need for continuous eye accommodation.[4] (see fig 10-6)
- The top of the CRT screen should be below eye height. The center of the screen should be between 10 degrees and 20 degrees below the horizontal plane at the user's eye height with no portion of the screen at an angle greater than 40 degrees below the horizontal. The most comfortable position is achieved when the operator's head is inclined 20 degrees to the vertical. When the CRT is too low, the operators are forced to incline their head more than this, thereby increasing the stress placed on their neck muscles.[1,4,25] (see fig 10-6)

DOCUMENT HOLDERS

- Document holders should be provided at every keyboard station to prevent unnecessary strain on the operator's neck muscles from frequent vertical nods of the head. An example of a document holder can be seen in Figure 10-14.
- The document holder should be flexible with regard to height, reading distance, and inclination, yet stay in position when placed there. Some provision should be made to keep the document in place (i.e., clips).
- The viewing angle of the document holder should be the same as the viewing angle of the CRT screen to keep the line of sight between the two consistent.

The optimum placement of the document holder is

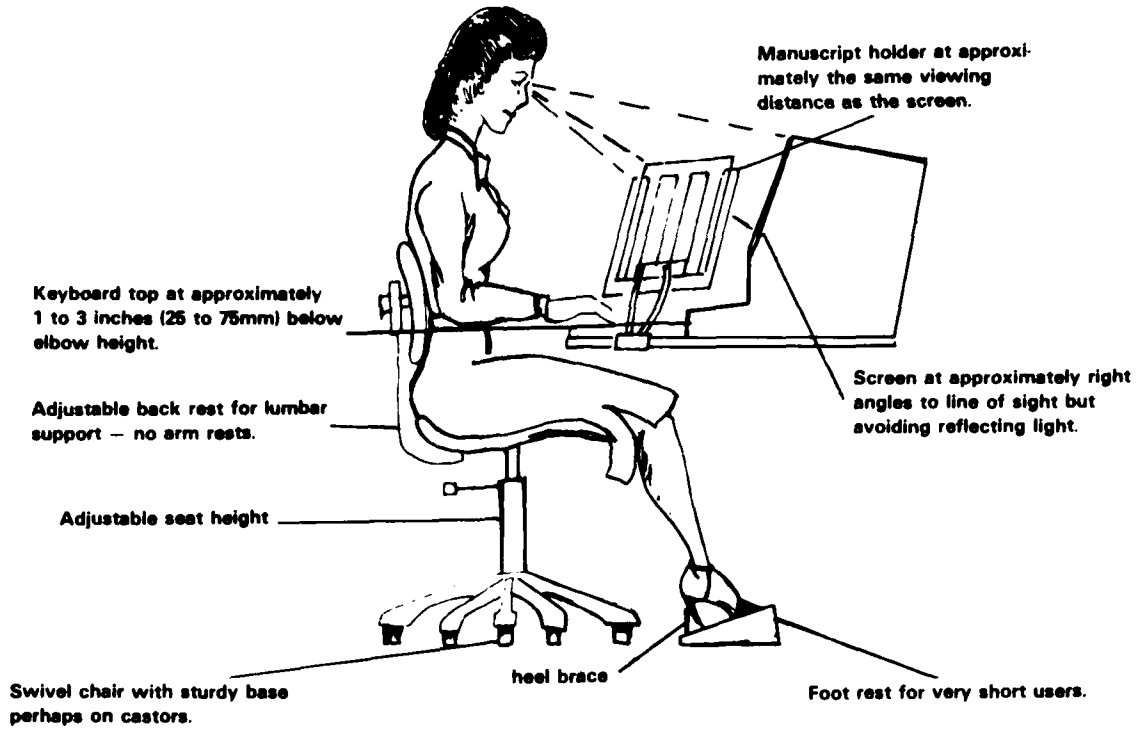


Figure 10-14. Typical CRT workstation

parallel to the CRT screen. This enables the user to proofread the copy by making a series of rapid eye movements instead of head movements.

The angle between the horizontal line of sight and a line from the eye to the light source should be more than 30 degrees unless some device such as a glare shield is used. This prevents glare from the lights impairing the operator's vision.[14 21]

LIGHTING

Objective

The main objective of lighting is to enable people to see in order to perform various tasks. Too much or too little illumination can create problems. As light levels increase, glare problems also increase. There is usually a range of light levels below which seeing is difficult and another range of light levels above which it either does not improve or becomes more difficult. The amount of light required for different types of tasks varies.[26]

- The level of illumination at the desk or terminal should range between 70 foot candles (fc) and 100 (fc).
- If the level of illumination is not adjustable, 100 fc is recommended as many of the CRT users require this level.
- The minimum level of illumination provided should be 50 fc.

Recommended light levels for various work areas are given in Tables 10-2 and 10-3, and are the basis for the guidelines below. There are many logical inferences from these lighting guidelines. For example:

The warehouse does not usually provide sufficient lighting for reading computer printouts or computer cards. If the warehouseman must read computer cards which are used as markings on bins, sufficient light must be provided to read the small alphanumerics on the cards. In this particular case, it may be more effective to use relatively large

alphanumerics to allow the warehouseman to quickly and accurately locate storage bins.[1]

Table 10-2. Desk or CRT illumination requirements.[3]

	Illumination levels in footcandles	
Work Task	***Recommendation***	***Minimum***
Business Machine Operation (Calculator digital, input, etc.)	100	50
Console Surface	50	30
Reading:		
Large Print	30	10
Newsprint	50	30
Handwritten Reports, in pencil	70	50
Small type	70	50
Prolonged Reading	70	50
Recording	70	50
Transcribing & Tabulation	100	50

Table 10-3. General illumination requirements.[3]

	Illumination levels in footcandles	
Work Area or Type of Task	***Recommendation***	***Minimum***
Corridors	20	10
Emergency lighting		3
Hallways	20	10
Ordinary seeing tasks	50	30
Passageways	30	10
Service areas (general)	20	10
Stairways	20	10
Storage:		
Inactive or dead	5	3
General warehouse	10	5
Live, rough, or bulk	10	5
Live, medium	30	20
Live, fine	50	30

Glare

Shadows and glare are the most commonly encountered problem in lighting system designs. The four most serious problems are illustrated in Figures 10-15 to 10-18.

- Diffused light sources (floruescent) are recommended to minimize glare and shadow effects.
- CRTs should have non-glare display surfaces because regardless of the mounting, they reflect overhead or other room lighting.
- A medium-gray or dull matte finish should be used on equipment, furniture, etc., adjacent to the display.
- A shield device (hood) can be used in some instances to keep as much glare as possible off the screen.
- Honeycomb grating should be hung below overhead lighting sources in order to limit glare.[2]

Light Conservation

As part of the Army's energy conservation program, designers should consider the following possibilities.

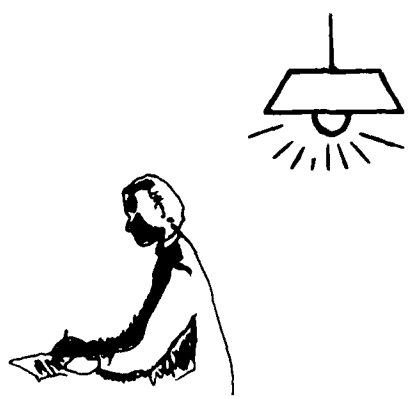


Figure 10-15. Light source positioning.

Shadows are cast by the observer onto the writing surface because of improper light source positioning. The light source should not be behind but instead should be located from slightly behind the worker to slightly in front of the worker and extend to the right and the left to minimize for both right-handed and left-handed persons.

- Task lighting combined with low ambient lighting may be the most effective approach since it provides the user adequate light to perform assigned tasks and to move from place to place
  - Selective circuit controls allow for the turning off or dimming of lights that are not being used within an area
  - Lighting systems for large areas should be provided with a central control switch so that the last person to leave can turn off the remaining lights. This switch should be placed at the entrance or exit so that the person does not have to walk through a dark room
  - Timing devices with sensors can be used to control lighting and shutter systems to take advantage of natural light.
  - Controlling ceiling lights by a dimmer system is a better energy savings approach than selectively turning off every other light. Dimmers do not create light and dark spots in the work area or in passageways.
  - "User presence" sensing devices are available and can be used effectively to turn off lights in unoccupied areas.

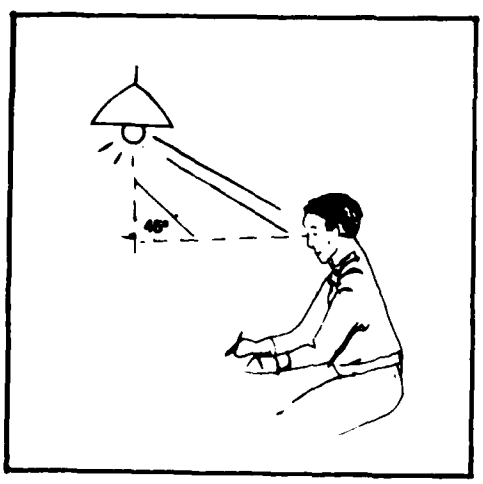


Figure 10-16. Light shielding.

The light source should not shine directly into employee's eyes. The light should be screened by a shield or distributing screen.

Supplementary lighting may be the most effective approach since it provides the user adequate light to perform assigned tasks and to move from place to place.

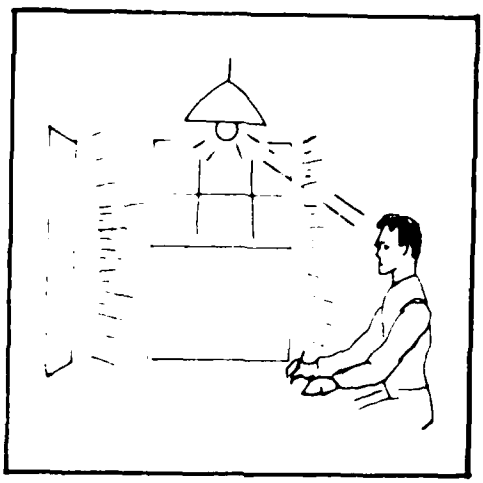


Figure 10-17. Ambient glare.

Ambient glare from lights or windows can make seeing difficult. Methods to overcome this problem include reorienting the workers, putting shades or curtains over the windows, and adding light-filtering materials.

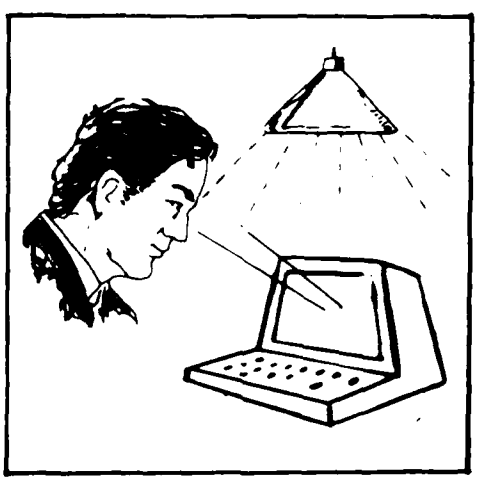


Figure 10-18. Specular glare.

- Reflected glare is caused by light thrown back from highly polished or glossy surfaces. It can be reduced by using dull mat surfaces, flat prints, desk blotter rather than polished surfaces.[26]

Selective circuit controls allow the turning off or dimming of lights that are not being used within an area. **WARNING:** Such systems must continue to provide enough light for a given visual operating area.

Lighting systems for large areas should be provided with a central control switch so that the last person to leave can turn off all the remaining lights.

Timing devices can be used to control lighting and shutter systems to take advantage of natural light.

Controlling ceiling lights by a dimmer system is a better energy savings approach than selectively turning off every other light. Dimmers do not create light and dark spots in the work area or in passageways.

"User presence" sensing devices are available and can be used effectively to turn off lights in unoccupied areas.[2]

Supplementary Lighting for the Individual Workplace

Lighting should be designed so that operators can select or adjust the best position for their seeing tasks. As their tasks change, so do their lighting requirements. If the lighting is fixed, it should be placed so that it does not reflect from the work surface or shine directly into the worker's eyes.

Ideally, the light should be slightly behind to directly overhead and extending to the left and the right in order to minimize shadows for both the right-handed and left-handed worker.

Figure 10-19 illustrates a typical flexible-arms light that allows the user to adjust light to a variety of positions.

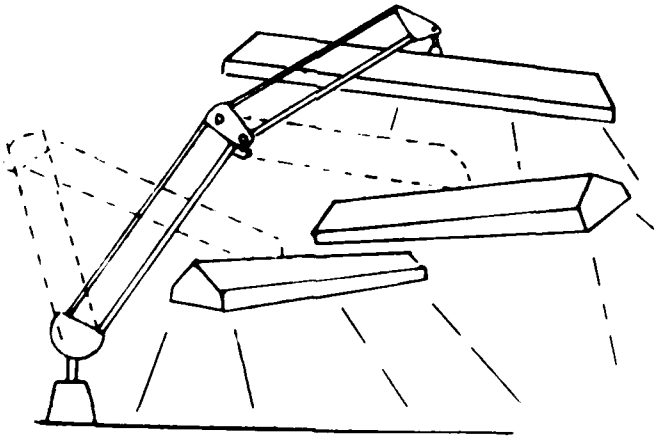


Figure 10-19. Supplementary workplace lighting.

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CHAPTER 10 CHECKLIST

	Yes	Not applicable	Not known *	no *
1. Are private offices available for personnel who conduct professional or supervisory counseling 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 × 7.5 ft. (23 × 23mm)?	☐	☐	☐	☐
12. Are the private offices designed 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 (55mm) 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?	☐	☐	☐	☐

	Yes	Not applicable	Not known *	no *
21. Is the modular furniture sturdy and self-supporting?	☐	☐	☐	☐
22. Does all of the furniture:				
a. wear well?	☐	☐	☐	☐
b. Clean easily?	☐	☐	☐	☐
23. Have all employees been given enough space, even in open offices?	☐	☐	☐	☐
24. In designing the office and individual workplace, have the following factors been considered:				
a. Electrical outlets?	☐	☐	☐	☐
b. Telephone outlets?	☐	☐	☐	☐
c. Air vents and return vents?	☐	☐	☐	☐
d. General materials storage?	☐	☐	☐	☐
e. Rest rooms?	☐	☐	☐	☐
f. Drinking fountains, coffee pot tables, refrigerators, vending machines?	☐	☐	☐	☐
g. Security systems, alarms, fire extinguishers, etc?	☐	☐	☐	☐
h. Housekeeping equipment, storage?	☐	☐	☐	☐
25. In order to ensure that the office does not preclude the employment of handicapped persons:				
a. Are the doorways and hallways wide enough for wheelchairs?	☐	☐	☐	☐
b. Are ramps or elevators provided so that access to all floors is not limited?	☐	☐	☐	☐
c. Have special rest room facilities been provided?	☐	☐	☐	☐
d. Can the individual workplaces accommodate wheelchairs?	☐	☐	☐	☐
26. Are self-explanatory signs provided for office identification?	☐	☐	☐	☐
27. At permanent and semi-permanent work sites, is the dry bulb temperature maintained above 65°F (18°C) and below 85°F (29.5°C)?	☐	☐	☐	☐
28. Does the amount of ventilation at each work site meet the following requirements:				
a. For any enclosure, a minimum of 30 feet ($8.5m^3$) per minute?	☐	☐	☐	☐
b. Is two-thirds of the air from the outside	☐	☐	☐	☐
c. Is the velocity of the air not more than 100 ft. ($30M^5$) per minute	☐	☐	☐	☐
29. Is cold air discharged away from personnel?	☐	☐	☐	☐
30. Is the relative humidity kept at 45 percent when the temperature is 70°F (21°C)?	☐	☐	☐	☐
31. Is the difference in the temperature between the floor and the ceiling kept at or below 10°?	☐	☐	☐	☐

	Yes	Not applicable	Not known *	no *
32. Are adjustable chairs and, where needed, adjustable footrests provided?	☐	☐	☐	☐
33. Are all corners and sharp edges of the furniture covered to protect users and passers by?	☐	☐	☐	☐
34. Is the CRT cushioned to protect it from being damaged if it is bumped?	☐	☐	☐	☐
35. Does the desk or table meet the following requirements:				
a. Height, 28-29 inches (71-74 cm)?	☐	☐	☐	☐
b. Where a keypad is used, a height of 26-27.5 inches (66-70cm)?	☐	☐	☐	☐
36. Are the employee's forearms horizontal to the work surface when typing?	☐	☐	☐	☐
37. Does each employee have enough desk space for all auxiliary supplies (e.g., telephone, reference books, etc.)?	☐	☐	☐	☐
38. In addition, does the employee have enough free desk space to accommodate a number of printouts if the job requires the use of more than one printout simultaneously?	☐	☐	☐	☐
39. Is the work surface at consoles large enough to accommodate a printout?	☐	☐	☐	☐
40. Is adequate storage provided at the immediate work station?	☐	☐	☐	☐
41. Is there enough storage space for current and expected future use?	☐	☐	☐	☐
42. Can items in storage be located, removed, and replaced without excessive physical strain or awkward body positions?	☐	☐	☐	☐
43. Is there storage space for personal items (e.g., umbrellas, coats, purses, etc.)?	☐	☐	☐	☐
44. Do the chairs provided for the employees conform to the following standards:				
a. Height of seat pan adjustable between 16 and 21 inches (40-52 cm)?	☐	☐	☐	☐
b. Height adjustment increments of 1 inch (25 mm)?	☐	☐	☐	☐
c. Depth of seat pan adjustable from 12-15 inches (300-400 mm)?	☐	☐	☐	☐
d. Is the shape of the seat pan:				
(1) Flat?	☐	☐	☐	☐
(2) Rounded front edge?	☐	☐	☐	☐
(3) Slight rearward declination of 3°-5°??	☐	☐	☐	☐
e. Seat width — a minimum of 15.7 inches (400 mm), and preferably wider?	☐	☐	☐	☐
f. Seat cushioning — flat and stiff, giving way one inch?	☐	☐	☐	☐

	Yes	Not applicable	Not known *	no *
45. Is each chair equipped with a backrest that meets the following requirements:				
a. Does the backrest engage the lumbar region of the seated person's back?	☐	☐	☐	☐
b. Is it small enough vertically that it does not interfere with arm and shoulder movement?	☐	☐	☐	☐
c. Is the back rest slightly concave toward the individual?	☐	☐	☐	☐
d. Are the edges rounded?	☐	☐	☐	☐
e. Is it slightly padded?	☐	☐	☐	☐
f. Is the space between seat pan and back rest adjustable between 4-10 inches (102-254 mm)?	☐	☐	☐	☐
g. Is the depth from the front edge of seat adjustable between 13.4-17.3 inches (340-440 mm)?	☐	☐	☐	☐
h. Does the angle swivel between 5° -15° backward from the vertical?	☐	☐	☐	☐
46. Are all the chairs provided with armrests?	☐	☐	☐	☐
47. Is the length of the armrest adjustable between 9-12 inches (229-305 mm)?	☐	☐	☐	☐
48. Is the height of the armrest adjustable in the range of 7-11 inches (178-279 mm)?	☐	☐	☐	☐
49. Are the armrests cushioned with the same type and amount of cushioning as the seat and the backrest?	☐	☐	☐	☐
50. Does the chair have at least a four-leg base?	☐	☐	☐	☐
51. Have lockable castors been provided when castors are desirable?	☐	☐	☐	☐
52. Have footrests been provided where needed to provide foot support?	☐	☐	☐	☐
53. Is the height of the footrest adjustable up to 4 inches (100 mm)?	☐	☐	☐	☐
54. Is the angle of inclination of the footrest adjustable from 0°-30°?	☐	☐	☐	☐
55. Is the user able to stabilize the footrest?	☐	☐	☐	☐
56. Is there a heel stop on any footrest which is adjustable to an angle greater than 15°?	☐	☐	☐	☐
57. Is the height of the knee room for each seated individual at least 25 inches (635 mm)?	☐	☐	☐	☐
58. Is the knee room depth for each seated individual at least 16 inches (406 mm)?	☐	☐	☐	☐
59. Where the employee is required to stretch his legs, is the knee room depth at least 24 inches (610 mm)?	☐	☐	☐	☐
60. Is the width of the knee room for a seated individual at least 20 inches (508 mm)?	☐	☐	☐	☐

	Yes	Not applicable	Not known *	no *
61. Is each employee able to adjust the furniture in such a position as to obtain a working level of between 8.7-9.8 inches (220-250 mm)?	☐	☐	☐	☐
62. Can each keyboard be detached from the CRT screen?	☐	☐	☐	☐
63. Are the keyboards positioned so that the height of the home row is between 28.3 inches and 29.5 inches (720-750 mm) above the floor?	☐	☐	☐	☐
64. Is the distance between the front edge of the desk and the back row of keys no more than 15.7 inches (400 mm)?	☐	☐	☐	☐
65. Is there a "free area" of approximately 2.4 inches (60 mm) in front of the keyboard for resting the hands?	☐	☐	☐	☐
66. Is the CRT screen approximately:				
a. 20 inches (508 mm) from the operator's eyes?	☐	☐	☐	☐
b. Not more than 27.6 inches (700 mm)?	☐	☐	☐	☐
67. Is the viewing distance to the keyboard between 17.7-19.7 inches (400-500 mm)?	☐	☐	☐	☐
68. Is the top of the CRT below the operator's eye height?	☐	☐	☐	☐
69. Is the center of the screen between 10° -20° below ther user's eye height?	☐	☐	☐	☐
70. Are document holders provided at each keyboard station?	☐	☐	☐	☐
71. Is the height of the document holder easily adjustable?	☐	☐	☐	☐
72. Can the distance from the document holder to the user be adjusted?	☐	☐	☐	☐
73. Can the angle of inclination of the document holder be adjusted?	☐	☐	☐	☐
74. Is the viewing angle of the document holder the same as the viewing angle of the CRT screen?	☐	☐	☐	☐
75. Is the angle between the horizontal line of sight and a line from the eye to the light source more than 30°?	☐	☐	☐	☐
76. Is the amount of background light adjustable between 70 fc and 100 fc?	☐	☐	☐	☐
77. If not adjustable, is it approximately 100 fc?	☐	☐	☐	☐
78. Are flourescent lights used at workstations to minimize glare?	☐	☐	☐	☐
79. Are the lights covered with honeycomb gratings?	☐	☐	☐	☐
80. Do all CRTs have non-glare display surfaces?	☐	☐	☐	☐
81 Does all the equipment have a dull matte finish?	☐	☐	☐	☐
82. Do the CRTs have hoods to prevent glare?	☐	☐	☐	☐
83. Are all windows out of the user's field of vision?	☐	☐	☐	☐

*Answers in these two columns require some action to obtain information or justify departing from the guidelines.

System Designer
Signature: _____ Date: _____

Approved by: _____ Date: _____

User acceptance: _____ Date: _____

APPENDIX A
COMMON PROBLEMS

System Design

Requirements are generated by users who lack knowledge of terminal limitations and capabilities.

Designers are not able to ascertain all of the functional user's needs.

Design may ignore current problems, especially those of data input.

Records of solutions to similar design problems usually are not available.

The time period of active data on-line is decreasing.

More interactive edit programs are needed.

Systems are altered too frequently.

Changes are frequently associated with new problems.

System Downtime and Overload

The systems are down or unavailable to users.

System response times are too slow.

System response times are inconsistent.

Access to the system is difficult.

There is no reserve for the expected surge if mobilization is required.

More users, greater load, and longer delays are expected in the future.

Adequate vendor service is not always provided.

Data Input

Keypunch

- There is delayed feedback on errors.
- Two or three runs occur before errors are corrected.
- Error correction is very time consuming.
- Keypunch operators have low morale as compared to CRT operators due to such things as antiquated equipment.

Terminal

- Touch is over or under sensitive.
- Separate numeric keypad is not provided, although it is needed.
- Glare on screen is bothersome.
- Flashing cursor is annoying.
- Repetitious message transmission errors frustrate users.
- Data input may require depression of space bar or other keys up tc 20 times to properly position each input.
- Typing echo is delayed.
- Log-in, log-out, and print procedures are too complex.
- Numeric, control, and function keys vary across equipment used.
- Not enough terminals are available.
- Error messages are meaningless.
- Whole page does not appear on the screen.
- Terminal location is inconvenient.

	Keypunch and Terminal
	Sequence of data does not conform to sequence of entry.
	Some data is re-entered into the system several times.
	Too many codes, many of which are not meaningful.
	Rules for the generation of the codes are not given.
	Time pressures of increased workload when system response is worst — end of month, quarter, fiscal year.
Data Manipulation	Inquiry formats are not standardized.
	Various inquiries cannot be combined.
Output	Data on output does not agree with "same" data on other outputs.
	Printout data does not conform to branch, division, or office requirements.
	All needed information is not on a single printout or terminal frame.
	Printout or terminal frame contains too much extraneous data.
	Employees perform tasks that are more appropriate for the computer.
	Changes are not identified since the last printout.
	Data fields are not separated on terminal frame or printout.
	Printout was received late or not received at all.
	Computer paper is difficult to manipulate and store.
	Cards and printouts are illegible.
	Carbon copies are difficult to sort.
	Microfiche is difficult to use.
	The title on the printout or terminal is not clear
Training	The training program is inadequate or nonexistent.
	Operating manuals are poorly designed.
	Users do not understand the computer.
Workplace Environment	Adequate furniture for MIS equipment is not provided.
	Furniture and equipment is not adjustable.
	Adequate workspace at CRT and desk is not provided.
	Arrangement of furniture and equipment is inadequate.
	Printers or copiers are very noisy.
	Temperature control in warehouses is inadequate.
	Lighting in warehouses is inadequate.
Communication	Request for changes take inordinate amount of time for completion.
	Feedback on suggestions is inadequate.
	Systems are not delivered on time.
	System status reports are not accurate.
	Security procedures are not understood.
	Procedures perceived to be unnecessary are resented.

APPENDIX B
USER EVALUATION FORMS

User evaluation forms have been developed from the problems encountered in numerous operating automated systems. These user forms are useful in uncovering potential system problems on CRTs or printouts. Several formats were developed to control for the psychometric deficiencies of each particular format. These forms are described below.

1. Terminal User Forms.

a. Section I. The statements are worded so that a "YES" response to numbers 2, 3, 6, 7, 8, 11, 12b, 15, 20, 22, 25, 28, 43, 46, and 52 indicate a problem; while a "NO" response to the other statements indicates a potential problem. If the questionnaire illustrated in Section I is given through the terminal, this format is recommended.

b. Section II. The statements are worded so that "NO" answers indicate a potential problem. This questionnaire, shown in Section II, is preferred if the questionnaires are to be hand scored.

c. Section III. This is a forced choice format. The first alternative in each case indicates a potential problem. It is shown in Section III.

2. Handcopy Product Forms.

a. Section IV. "NO" answers indicate a potential problem.

b. Section V. The first alternative indicates a potential problem.

Section I. TERMINAL USER EVALUATION FORM

The purpose of this evaluation form is to improve the computer system(s) and printout(s) which you use. If you put your name on the questionnaire, feedback concerning the problems you have identified will be provided. Thank you for your cooperation.

System Evaluated _____

Date _____(day) ____(month) ____(year)

Experience with this system _____(years) _____(months)

Name (optional) _____

Branch/Division (optional) _____

Job Title (optional) _____

Nature of Primary Use _____ input

_____ change or update data

_____ check data

_____ retrieve data

Please check your choice or fill in an answer for each statement.

	Yes	*No*	*Not applicable*	*Do not know*
1. The system does all that it should to allow me to perform the tasks of my job.				

APPENDIX B–Continued
Section I–Continued

	Yes	No	Not applicable	Do not know
2. The system should be changed.	___	___	___	___
3. System downtime is a problem.	___	___	___	___
4. The system has been unavailable ____ times in the last week for a total time of ____ hours.	____			
5. The system response time to answer requests or demands is adequate.	____	___	___	___
6. I need further training in the use of the system.	___	___	___	___
7. I would like a tour of the central computer room.	___	___	___	___
8. I would like a nontechnical presentation of how the computer system works.	___	___	___	___
9. The user manual is easy to use.	___	___	___	___
10. The user manual is regularly updated.	___	___	___	___
11. The user manual contains examples or instructions which would lead to incorrect entries.	___	___	___	___
12. a. The data on a single frame on the terminal supplies all the information I need for task completion.	___	___	___	___
b. I usually have to combine data from terminal frames & printouts to perform my required tasks.	___	___	___	___
13. The "touch" of the keys on the terminal is adequate.	___	___	___	___
14. I input a lot of numerical data, and there is a numeric key pad on the terminal.	___	___	___	___
15. Glare on the terminal screen is a problem.	___	___	___	___
16. There is nothing about the terminal screen that is bothersome.	___	___	___	___
17. I must press the space bar or a key ___?___ times in order to properly enter some data.	___			
18. Correction of errors is easy.	___	___	___	___
19. To correct errors, I just have to retype the segment that was wrong.	___	___	___	___
20. It is difficult to log-in or have commands executed.	___	___	___	___
21. Log-in or print procedures are fast and efficient.	___	___	___	___
22. There is a noticeable delay between striking a key and the printing of the character.	___	___	___	___
23. Sequence of data entry matches sequence on the form from which data is obtained.	___	___	___	___
24. The same data is input only once.	___	___	___	___
25. Numeric, function, or control keys vary on the office equipment I use.	___	___	___	___
26. The codes used are easy to learn.	___	___	___	___
27. The codes by themselves are meaningful.	___	___	___	___

APPENDIX B–Continued
Section I–Continued

	Yes	*No*	*Not applicable*	*Do not know*
28. Difficulty in meeting deadlines (end of month, end of quarter, end of fiscal year) can be attributed to the computer system.	____	____	____	____
29. There are enough terminals.	____	____	____	____
30. Error messages specify what is wrong.	____	____	____	____
31. Error messages indicate how to correct errors.	____	____	____	____
32. The whole page is presented on the screen.	____	____	____	____
33. There is a standard inquiry format for all inquiries.	____	____	____	____
34. Inquiries can be combined.	____	____	____	____
35. The computer always accepts data or commands.	____	____	____	____
36. There is an indication of who made what changes, and when they were made.	____	____	____	____
37. There is an indication of the number of changes since the last printout.	____	____	____	____
38. There is an indication of what the changes from the last printout are.	____	____	____	____
39. Data fields are all separated.	____	____	____	____
40. Data is easily located.	____	____	____	____
41. Output is always received on time.	____	____	____	____
42. Fiche is easy to use in conjunction with the terminal.	____	____	____	____
43. Fiche cause eye strain, headaches, or other physical ailments.	____	____	____	____
44. The desk or stand for the terminal is adequate.	____	____	____	____
45. I have enough storage space in my desk and cabinets.	____	____	____	____
46. I am bothered by noise at my worksite.	____	____	____	____
47. The temperature is kept at a comfortable level.	____	____	____	____
48. The lighting at my worksite is adequate.	____	____	____	____
49. The office furniture and equipment are arranged for ease of use, convenience, and comfort.	____	____	____	____
50. Request for changes to the system take approximately ___?___ days to be implemented.				
51. Changes to the system seldom create new problems.	____	____	____	____
52. Security procedures are a problem.	____	____	____	____
53. System status is on a recorded message which is up to date and accurate.				
54. Please list any problems not previously noted in preparing data for the computer, manipulating or changing computer data or in receiving computer data.				

APPENDIX B–Continued
Section II. TERMINAL USER/EVALUATION FORM

The purpose of this evaluation form is to improve the computer system(s) and printout(s) which you use. If you put your name on the questionnaire, feedback concerning the problems you have identified will be provided. Thank you for your cooperation.

System Evaluated _____

Date _____(day) ____(month) ____(year)

Experience with this system _____(years) _____(months)

Name (optional) _____

Branch/Division (optional) _____

Job Title (optional) _____

Nature of Primary Use _____ input
_____ change or update data
_____ check data
_____ retrieve data

Please check your choice or fill in an answer for each statement.

	Yes	*No*	*Not applicable*	*Do not know*
1. The system does all that it should to allow me to perform the tasks of my job.	___	___	___	___
2. The system should NOT be changed.	___	___	___	___
3. System downtime is NOT a problem.	___	___	___	___
4. The system has been unavailable ___ times in the last week for a total time of ___ hours.		___		
5. The system response time to answer requests or demands is adequate.	___	___	___	___
6. I do not need further training in the use of the system.	___	___	___	___
7. I would NOT like a tour of the central computer room.	___	___	___	___
8. I would NOT like a nontechnical presentation of how the computer system works.	___	___	___	___
9. The user manual is easy to use.	___	___	___	___
10. The user manual is regularly updated.	___	___	___	___
11. The user manual contains NO examples or instructions which would lead to incorrect entries.	___	___	___	___
12. a. The data on a single frame on the terminal supplies all the information I need for task completion.	___	___	___	___
b. I usually do NOT have to combine data from terminal frames & printouts to perform my required tasks.	___	___	___	___
13. The "touch" of the keys on the terminal is adequate.	___	___	___	___

APPENDIX B–Continued
Section II–Continued

	Yes	No	Not applicable	Do not know
14. I input a lot of numerical data, and there is a numeric key pad on the terminal.	___	___	___	___
15. Glare on the terminal screen is NOT a problem.	___	___	___	___
16. There is nothing about the terminal screen that is bothersome.	___	___	___	___
17. I must press the space bar or a key ___?___ times in order to properly enter some data.		___		
18. Correction of errors is easy.	___	___	___	___
19. To correct errors, I just have to retype the segment that was wrong.	___	___	___	___
20. It is NOT difficult to log-in or have commands executed.	___	___	___	___
21. Log-in or print procedures are fast and efficient.	___	___	___	___
22. There is not a noticeable delay between striking a key and the printing of the character.	___	___	___	___
23. Sequence of data entry matches sequence on the form from which data is obtained.	___	___	___	___
24. The same data is input only once.	___	___	___	___
25. Numeric, function, or control keys do not vary on the office equipment I use.	___	___	___	___
26. The codes used are easy to learn.	___	___	___	___
27. The codes by themselves are meaningful.	___	___	___	___
28. Difficulty in meeting deadlines (end of month, end of quarter, end of fiscal year) can NOT be attributed to the computer system.	___	___	___	___
29. There are enough terminals.	___	___	___	___
30. Error messages specify what is wrong.	___	___	___	___
31. Error messages indicate how to correct errors.	___	___	___	___
32. The whole page is presented on the screen.	___	___	___	___
33. There is a standard inquiry format for all inquiries.	___	___	___	___
34. Inquiries can be combined.	___	___	___	___
35. The computer always accepts data or commands.	___	___	___	___
36. There is an indication of who made what changes, and when they were made.	___	___	___	___
37. There is an indication of the number of changes since the last printout.	___	___	___	___
38. There is an indication of what the changes from the last printout are.	___	___	___	___
39. Data fields are all separated.	___	___	___	___

APPENDIX B–Continued
Section II–Continued

	Yes	*No*	*Not applicable*	*Do not know*
40. Data is easily located.	____	____	____	____
41. Fiche is easy to use in conjunction with the terminal.	____	____	____	____
42. Fiche does not cause eye strain, headaches, or other physical ailments.	____	____	____	____
43. The desk or stand for the terminal is adequate.	____	____	____	____
44. I have enough storage space in my desk and cabinets.	____	____	____	____
45. I am not bothered by noise at my worksite.	____	____	____	____
46. The temperature is kept at a comfortable level.	____	____	____	____
47. The lighting at my worksite is adequate.	____	____	____	____
48. The office furniture and equipment are arranged for ease of use, convenience, and comfort.	____	____	____	____
49. Request for changes to the system take approximately ___?___ days to be implemented.		____		
50. Changes to the system seldom create new problems.	____	____	____	____
51. Security procedures are not a problem.	____	____	____	____
52. System status is on a recorded message which is up to date and accurate.	____	____	____	____

53. Please list any problems not previously noted in preparing data for the computer, manipulating or changing computer data, or in receiving computer data.

54. I suggest the following ways to improve this questionnaire.

APPENDIX B–Continued

Section III. TERMINAL USER EVALUATION FORM

The purpose of this evaluation form is to improve the computer system(s) and printout(s) which you use. If you put your name on the questionnaire, feedback concerning the problems you have identified will be provided. Thank you for your cooperation.

System Evaluated _____

Date _____(day) _____(month) _____(year)

Experience with the system _____(years) _____(months)

Name (optional) _____

Branch/Division (optional) _____

Job Title (optional) _____

Nature of Primary Use _____ input
_____ change or update data
_____ check data
_____ retrieve data

Please check your choice or fill in an answer for each statement.

1. The system is down	__ often	__ infrequently
Give an estimate of weekly downtime, if possible.	__	
2. The system response time is usually	__ slow	__ sufficient
3. The user manuals are	__ not current	__ current
4. The user manuals are	__ inadequate	__ adequate
5. The user manual contains inaccuracies	__ many	__ few
6. The amount of information displayed on the CRT screen for tasks I usually perform is	__ not complete	__ complete
7. The touch of the keys on the terminal is	__ not acceptable	__ acceptable
8. Do you have a numeric key pad?	__ no	__ yes
Would you use one if you had it?	__ yes	__ no
9. I experience glare on my terminal screen	__ often	__ infrequently
10. I must press the space bar or key in order to enter data	__ one or more times	__ none
11. Error correction is _____	__ difficult	__ easy
12. Log-in procedures are	__ difficult	__ easy
13. Log-out procedures are	__ difficult	__ easy
14. Command procedures are	__ difficult	__ easy
15. Print procedures are	__ difficult	__ easy
16. Log-in procedures are	__ lengthy	__ quick
17. Log-out procedures are	__ lengthy	__ quick
18. Command procedures are	__ lengthy	__ quick
19. Print procedures are	__ lengthy	__ quick

APPENDIX B–Continued
Section III–Continued

20. There is a delay between striking a key and the printing of the character	yes	no
21. The sequence of data entry matches the sequence on the source data form	infrequently	often
22. The same data must be re-input several times for different jobs	often	infrequently
23. The keyboard arrangements of the office equipment used in the job are	different	identical
24. The specific codes used in the job are by themselves	not meaningful	meaningful
25. Deadlines are difficult to meet	often	infrequently
26. The number of terminals in your division is	not adequate	adequate
27. Error messages indicate what the error is	infrequently	often
28. Error messages indicate how to correct the error	infrequently	often
29. Do you use a standardized format for all of your inquiries?	no	yes
30. Can inquiries be combined?	no	yes
31. The computer does not accept data	often	infrequently
32. The computer does not accept commands	often	infrequently
33. Changes since the last printout are indicated	infrequently	often
34. Data on the printouts are separated	no	yes
35. The specific data you are looking for is difficult to locate	often	infrequently
36. Information requested is received on time	infrequently	often
37. Do you ever use microfiche in conjunction with the terminal	yes	no
38. The use of both fiche and terminal is	difficult	easy
39. Do you notice any physical problems using the microfiche	yes	no
If yes, what are they?		
40. My terminal work area is	inadequate	adequate
41. My storage space is	inadequate	adequate
42. The noise level of my working environment is	not acceptable	acceptable
43. The room temperature is	inadequate	adequate
44. The room lighting is	inadequate	adequate
45. Requests for changes to the system are accomplished	slowly	rapidly
46. Changes to the system create new problems	often	infreqently

APPENDIX B–Continued
Section III–Continued

47. Security procedures for entering the system are	__ inadequate	__ adequate
48. Immediate information on the status of the system is available	__ infrequently	__ often
49. I would like to receive further training in the use of the system.	__ yes	__ no
50. I would like a tour of our central computer room.	__ yes	__ no
51. I would like a non-technical presentation on how the computer system works.	__ yes	__ no

52. Please list any other problems you have concerning use of the computer or computer products.

53. How would you change the system to accommodate you better?

APPENDIX B–Continued

Section IV. HARDCOPY EVALUATION FORM

The purpose of this evaluation form is to improve the computer system(s) and printout(s) which you use. If you put your name on the questionnaire, feedback concerning the problems you have identified will be provided. Thank you for your cooperation.

Printout Title _____

Date _____(day) _____(month) _____(year)

Experience with the system _____(years) _____(months)

Name (optional) _____

Branch/Division (optional) _____

Job Title (optional) _____

Nature of Primary Use
_____ input
_____ change or update data
_____ check data
_____ retrieve data

Please check your choice or fill in an answer for each statement.

	Yes	No	Not applicable	Do not know
1. The title on this printout is meaningful.	____	____	____	____
2. The printout supplies all the information I need.	____	____	____	____
3. The printout should NOT be changed.	____	____	____	____
4. I have to combine data from ____ printouts to perform my required tasks.				
5. The number of changes to the printout is acceptable	____	____	____	____
6. Data on this printout is consistent with data from other printouts.	____	____	____	____
7. Printout data conforms to branch/division requirements.	____	____	____	____
8. The printout arrives on time to perform my tasks.	____	____	____	____
9. The size of the computer paper and its folding accordian style does not cause me any difficulties.	____	____	____	____
10. I never have to add columns of numbers from a printout.	____	____	____	____
11. The printouts I receive are easy to read.	____	____	____	____
12. Fiche is easy to use in conjunction with the printout.	____	____	____	____
13. When I use fiche, I do NOT get eyestrain, headaches, or other physical ailments.	____	____	____	____

APPENDIX B–Continued

Section V. HARDCOPY EVALUATION FORM

The purpose of this evaluation form is to improve the computer system(s) and printout(s) which you use. If you put your name on the questionnaire, feedback concerning the problems you have identified will be provided. Thank you for your cooperation.

Report Title _____

Date _____(day) _____(month) _____(year)

Experience with the system _____(years) _____(months)

Name (optional) _____

Branch/Division (optional) _____

Job Title (optional) _____

Nature of Primary Use
_____ input
_____ change or update data
_____ check data
_____ retrieve data

Please check your choice or fill in an answer for each statement.

1. Do you feel that the titles on the printout that you use are:	__ not meaningful	__ meaningful
2. Does this printout contain all the information that you need?	__ no	__ yes
3. The printout is changed	__ often	__ infrequently
4. It is necessary for me to combine information from separate printouts	__ often	__ infrequently
5. The data on this printer is ____ when received	__ not current	__ current
6. The data on this printout are for my purposes	__ inaccurate	__ accurate
7. The data on this printout conform to branch/division requirements	__ does not	__ does
8. The printouts arrive for the purpose of my job	__ late	__ on time

APPENDIX C[1]

GLOSSARY OF COMMANDS

Section I. USER INTERFACE COMMANDS

COMMAND	*OPERATION*
1. ACKNOWLEDGE	Acknowledge a message from the CPU or another terminal
2. ADD	Accumulate incoming numeric values, summing to a total
3. ADVISE	Notify user or operator of another terminal or condition or event
4. APPEND	Append new information to a file or set of information
5. BREAK	Stop print, stop processing
6. CALENDAR	Print schedule or calendar
7. CALL	Call file or set of information
8. COPY	Copy a file or set of information
9. DECREASE	Decrease a counter
10. DELAY	Delay for stated amount of time
11. DELETE	Delete an existing file or set of information
12. EDIT	Edit a file or set of information
13. END	End action
14. EXECUTE	Activate the system or perform command(s)
15. EXTRACT	Extract portion from file or set of information
16. FORMAT	Define an input or output format
17. GET	Indicate a file or set of information with which to work
18. HELP	Lend assistance
19. INCREASE	Increment a counter
20. INDEX	Display index of files available
21. INQUIRY	Indicate type of function needed
22. INSERT	Insert new information in file or set of information
23. LOGOFF	Leave the system
24. LOGON	Enter the system
25. MERGE	Merge data into file or set of information
26. NEWFILE	Create a new file or set of information
27. PAGE AHEAD	Page ahead or forward
28. PAGE BACK	Page backward
29. PAUSE	Stop temporarily

[1] This appendix has been adopted from the US Army Research Institute's (ARI) in-process review of "Development Guidelines and Criteria for User/Operator Transactions with Battlefield Automated Systems", Volume IV, August 1980, contract monitor R.C. Sidorsky. We wish to acknowledge the work of ARI, while taking responsibility for our interpretation of their work. These are suggestions rather than prescriptions. The commands have not been empirically confirmed, nor do they represent a comprehensive review of command words and functions.

APPENDIX C–Continued

Section I–Continued

COMMAND	*OPERATION*
30. PRINT	Print a hard copy
31. PROTECT	Protect a file or set of information
32. SAVE	Store a file or set of information
33. SEARCH	Find designated file
34. SELECT	Select or activate a computer-controlled device
35. SHOW	Display the content of a field
36. SORT	Sort data in a file or set of information
37. STATUS	Get system status
38. WAIT	Wait for input
39. WRITE	Store a file or set of information on disk Print a hardcopy Display the content of a field Define an input or output format

Section II. POTENTIAL COMMANDS AND RECOMMENDED COMMANDS

		RECOMMENDATIONS	
POTENTIAL COMMANDS	*OPERATION*	*RECOMMENDED COMMAND*	*ABBREVIATIONS[1] (4-CHAR)*
ABORT	Leave the system	LOGOFF	LOGF
	Delete an existing file or set of information	DE[illegible]TE	DELE
ACCRETE	Accumulate incoming numeric values, summing to a total	ADD	ADD
ACCUMULATE	Accumulate incoming numeric values, summing to a total	ADD	ADD
ACKNOWLEDGE	Acknowledge a message from the CPU or another terminal	ACKNOWLEDGE	ACKN
ACTIVATE	Select or activate a computer-controlled device	SELECT	SELE

[1] Formed by taking first 4 letters of the command when possible.

APPENDIX C–Continued

Section II–Continued

POTENTIAL COMMANDS	OPERATION	RECOMMENDATIONS: RECOMMENDED COMMAND	RECOMMENDATIONS: ABBREVIATIONS[3] (4-CHAR)
ACTUATE	Select or activate a computer-controlled device	SELECT	SELE
ADD	Accumulate incoming numeric values, summing to a total	ADD	ADD
	Append new information to a file or set of information	APPEND	APPE
	Increment a counter	INCREASE	INCR
ADJOIN	Merge data into a file or set of information	MERGE	MERG
ADVANCE	Increment a counter	INCREASE	INCR
ADVISE	Notify user of operator or another terminal of a condition or event	ADVISE	ADVI
AFFIX	Select or activate a computer-controlled device	SELECT	SELE
APPEND	Append new information to a file or set of information	APPEND	APPE
APPRISE	Notify user or operator or another terminal of a condition or event	ADVISE	ADVI
ARRANGE	Sort data in a file or set of information	SORT	SORT
ARRAY	Sort data in a file or set of information	SORT	SORT
ASSORT	Sort data in a file or set of information	SORT	SORT
ATTACH	Select or activate a computer-controlled device	SELECT	SELE
	Append new information to a file or set of information	APPEND	APPE
.	.	.	.
.	.	.	.
BACK	Page backward	PAGE BACK	PAGB
BACKWARD	Page backward	PAGE BACK	PAGB
BEGIN	Enter the system	LOGON	LOGN
BREAK	Stop print	BREAK	BREA
BYE	Leave the system	LOGOFF	LOGF
.	.	.	.
.	.	.	.
CALENDAR	Print schedule or calendar	CALENDAR	CALE
CALL	Call file or set of information	CALL	CALL
CARRIAGE RETURN	Page forward	PAGE AHEAD	PAGA
CEASE	End	END	END
CLEAR	Delete an existing file or set of information	DELETE	DELE
CLONE	Copy a file or set of information	COPY	COPY
CONCATENATE	Merge data into a file or set of information	MERGE	MERG
CONNECT	Select or activate a computer-controlled device	SELECT	SELE

APPENDIX C–Continued
Section II–Continued

POTENTIAL COMMANDS	OPERATION	RECOMMENDATIONS: RECOMMENDED COMMAND	RECOMMENDATIONS: ABBREVIATIONS[1] (4-CHAR)
	Indicate a file or set of information with which to work	GET	GET
	Merge data into a file or set of information	MERGE	MERG
CONTINUE	Continue with current action	CONTINUE	CONT
COPY	Append new information to a file or set of information	APPEND	APPE
	Copy a file or set of information	COPY	COPY
	Print a hardcopy	PRINT	PRIN
	Store a file or set of information	SAVE	SAVE
CREATE	Create a new file or set of information	NEWFILE	NEWF
.	.	.	.
.	.	.	.
DECREASE	Decrease a counter	DECREASE	DECR
DEFINE	Indicate a file or set of information to work with	GET	GET
DELAY	Delay for stated amount of time	DELAY	DELA
DELETE	Delete an existing file or set of information	DELETE	DELE
DESTROY	Delete an existing file or set of information	DELETE	DELE
DIRECTORY	Display index of all available files of information	INDEX	INDE
DISCONTINUE	Discontinue print of file or set of information	BREAK	BREA
DISK	Store a file or set of information on disk	SAVE	SAVE
DISPLAY	Display the content of a field	SHOW	SHOW
DONE	Leave the system	LOGOFF	LOGF
DUP	Copy a file or set of information	COPY	COPY
DUPLICATE	Copy a file or set of information	COPY	COPY
.	.	.	.
.	.	.	.
ED	Edit a file or set of information	EDIT	EDIT
EDIT	Edit a file or set of information	EDIT	EDIT
END	Leave the system	LOGOFF	LOGF
ENTER	Enter the system	LOGON	LOGN
EXECUTE	Activate the system	EXECUTE	EXEC
EXTRACT	Extract portion from file or set of information	EXTRACT	EXTR
.	.	.	.
.	.	.	.
FETCH	Indicate a file or set of information to work with	GET	GET

APPENDIX C–Continued
Section II–Continued

POTENTIAL COMMANDS	OPERATION	RECOMMENDATIONS: RECOMMENDED COMMAND	RECOMMENDATIONS: ABBREVIATIONS* (4-CHAR)
FILE	Display index of all files	INDEX	INDE
	Create a new file or set of information	NEWFILE	NEWF
	Indicate a file or set of information to work with	GET	GET
	Store a file or set of information	SAVE	SAVE
FILE =	Create a new file or set of information	NEWFILE	NEWF
	Indicate a file or set of information	GET	GET
FILEOUT	Store a file or set of information	SAVE	SAVE
FIND	Indicate a file or set of information with which to work	GET	GET
FORM	Define an input or output format	FORMAT	FORM
FORMAT	Define an input or output format	FORMAT	FORM
FORWARD	Page forward	PAGE AHEAD	PAGA
.	.	.	.
.	.	.	.
GET	Indicate a file or set of information with which to work	GET	GET
GO	Activate a computer-controlled device	EXECUTE	EXEC
.	.	.	.
.	.	.	.
HELP	Lend assistance	HELP	HELP
HOLD D	Store a file or set of information on disk	SAVE	SAVE
HOLD T	Store a file or set of information on tape	SAVE	SAVE
.	.	.	.
.	.	.	.
ID	Enter the system	LOGON	LOGN
IDENT	Enter the system	LOGON	LOGN
INCREASE	Increment a counter	INCREASE	INCR
INCREMENT	Increment a counter	INCREASE	INCR
INDEX	Display index of all files	INDEX	INDE
INPUT	Define all input or output format	FORMAT	FORM
INQUIRY	Indicate type of function needed	INQUIRY	INQU
INSERT	Insert new information in file or set of information	INSERT	INSE
.	.	.	.
.	.	.	.
JOIN	Merge data into a file or set of information	MERGE	MERG
.	.	.	.
.	.	.	.
KEEP	Store a file or set of information	SAVE	SAVE

APPENDIX C–Continued
Section II–Continued

POTENTIAL COMMANDS	OPERATION	RECOMMENDATIONS	
		RECOMMENDED COMMAND	ABBREVIATIONS[3] (4-CHAR)
KILL	Delete an existing file or set of information	DELETE	DELE
.	.	.	.
.	.	.	.
LIST	Print a hardcopy	PRINT	PRIN
	Display the content of a field	SHOW	SHOW
LOAD	Indicate a file or set of information with which to work	GET	GET
LOGOFF	Leave the system	LOGOFF	LOGF
LOGON	Enter the system	LOGON	LOGN
LP	Print a hard copy	PRINT	PRIN
.	.	.	.
.	.	.	.
MERGE	Merge data into file or set of information	MERGE	MERG
MESSAGE	Acknowledge a message from the CPU or another terminal	ACKNOWLEDGE	ACKN
.	.	.	.
.	.	.	.
NEW	Create a new file or set of information	NEWFILE	NEWF
NEWFILE	Create a new file or set of information	NEWFILE	NEWF
NEXT	Page forward	PAGE AHEAD	PAGE
NOTIFY	Notify user/operator or another terminal of of a condition or event	TELL	TELL
.	.	.	.
.	.	.	.
OFF	Leave the system	LOGOFF	LOGF
OMIT	Delete an existing file or set of information	DELETE	DELE
ORDER	Sort data in a file or set of information	SORT	SORT
OUTPUT	Print a hardcopy	PRINT	PRIN
	Define an input or output format	FORMAT	FORM
.	.	.	.
.	.	.	.
PAGE	Page forward	PAGE AHEAD	PAGA
	Page backward	PAGE BACK	PAGB
PAGE AHEAD	Page forward	PAGE AHEAD	PAGA
PAGE BACK	Page backward	PAGE BACK	PAGB
PAGE FORWARD	Page forward	PAGE AHEAD	PAGA
PAUSE	Stop temporarily	PAUSE	PAUS
PRESERVE	Protect a file or set of information	PROTECT	PROT

APPENDIX C–Continued
Section II–Continued

POTENTIAL COMMANDS	OPERATION	RECOMMENDATIONS	
		RECOMMENDED COMMAND	ABBREVIATIONS[3] (4-CHAR)
PREVIOUS	Page backward	PAGEBACK	PAGB
PRINT	Print a hardcopy	PRINT	PRIN
PROTECT	Protect a file or set of information	PROTECT	PROT
PURGE	Delete an existing file or set of information	DELETE	DELE
.	.	.	.
.	.	.	.
QUIT	Leave the system	LOGOFF	LOGF
.	.	.	.
.	.	.	.
READ	Protect a file or set of information	PROTECT	PROT
RECALL	Indicate a file or set of information with which to work	GET	GET
RECORD	Store a file or set of information	SAVE	SAVE
RECORD D	Store a file or set of information on disk	SAVE	SAVE
RECORD T	Write a file or set of information on tape	SAVE	SAVE
REMOVE	Delete an existing file or set of information	DELETE	DELE
REPEAT	Copy a file or set of information	COPY	COPY
REPORT	Define an input or output format	FORMAT	FORM
REQUEST	Indicate a file or set of information with which to work	GET	GET
RETAIN	Store a file or set of information	SAVE	SAVE
REWRITE	Copy a file or set of information	COPY	COPY
RUN	Activate system	EXECUTE	EXEC
.	.	.	.
.	.	.	.
SAVE	Store a file or set of information	SAVE	SAVE
	Write a file or set of information	SAVE	SAVE
	Protect a file or set of information	PROTECT	PROT
SCHEDULE	Print schedule or calendar	CALENDAR	CALE
SEARCH	Find designated file	SEARCH	SEAR
SEEK	Find designated file	SEARCH	SEAR
SELECT	Select or activate a computer-controlled device	SELECT	SELE
	Indicate a file or set of information with which to work	GET	GET
SEQUENCE	Sort data in a file or set of information	SORT	SORT
SHOW	Display the content of a field	SHOW	SHOW
SIGNOFF	Leave the system	LOGOFF	LOGF

APPENDIX C–Continued
Section II–Continued

POTENTIAL COMMANDS	OPERATION	RECOMMENDATIONS	
		RECOMMENDED COMMAND	ABBREVIATIONS[3] (4-CHAR)
SIGNON	Enter the system	LOGON	LOGN
SORT	Sort data in a file or set of information	SORT	SORT
START	Activate the system	EXECUTE	EXEC
STATUS	Get system status	STATUS	STAT
STATUS R	Protect a file or set of information	PROTECT	PROT
STOP	Leave the system	LOGOFF	LOGF
	End	BREAK	BREA
STORE	Store a file or set of information	SAVE	SAVE
SUM	Add	ADD	ADD
SYSTAT	Get system status	STATUS	STAT
.	.	.	.
.	.	.	.
TAPE	Write a file or set of information on tape	SAVE	SAVE
TAPEOUT	Write a file or set of information on tape	WRITE	WRIT
TELL	Notify user or operator or another terminal of condition or event	ADVISE	ADVI
TERMINAL	Display the content of a field	SHOW	SHOW
TO =	Display the content of a field	SHOW	SHOW
TOUT	Write a file or set of information on tape	SAVE	SAVE
.	.	.	.
.	.	.	.
UNSAVE	Delete an existing file or set of information	DELETE	DELE
UPDATE	Edit	EDIT	EDIT
USE	Indicate a file or set of information with which to work	GET	GET
USER	Enter the system	LOGON	LOGN
.	.	.	.
.	.	.	.
WAIT	Wait for input	WAIT	WAIT
WRITE	Store a file or set of information	SAVE	SAVE
	Print a hardcopy	PRINT	PRIN
	Display the content of a field	SHOW	SHOW
	Define an input or output format	FORMAT	FORM
WRITE TO DISK	Store a file or set of information on disk	SAVE	SAVE
WRITE TO TAPE	Write a file or set of information on tape	SAVE	SAVE
W2DK	Store a file or set of information on disk	SAVE	SAVE
W2TO	Display the content of a field	SHOW	SHOW
W2TP	Write a file or set of information on tape	SAVE	SAVE

APPENDIX C–Continued

Section II–Continued

POTENTIAL COMMANDS	OPERATION	RECOMMENDATIONS: RECOMMENDED COMMAND	RECOMMENDATIONS: ABBREVIATIONS[3] (4-CHAR)
.	.	.	.
.	.	.	.
ZAP	Delete an existing file or set of information	DELETE	DELE

Section III. OPERATIONS AND RECOMMENDED COMMANDS[4]

OPERATION	POTENTIAL COMMANDS	RECOMMENDATIONS: COMMAND	RECOMMENDATIONS: ABBREVIATIONS[3] (4-CHAR)
Accumulate incoming numeric values, summing to a total	ADD ACCRETE ACCUMULATE SUM	ADD	ADD
Acknowledge a message from the CPU or another terminal	ACKNOWLEDGE MESSAGE	ACKNOWLEDGE	ACKN
Activate the system	EXECUTE RUN START	EXECUTE	EXEC
Append new information to a file or set of information	ADD AFFIX APPEND ATTACH COPY INSERT	APPEND	APPE
Call file or set of information	CALL	CALL	CALL
Copy a file or set of information	CLONE COPY DUP DUPLICATE REWRITE REPEAT	COPY	COPY
Continue with current action	CONTINUE	CONTINUE	CONT
Copy a new file or set of information	CREATE FILE FILE = NEW NEWFILE	NEWFILE	NEWF
Decrease a counter	DECREASE	DECREASE	DECR

[3] Formed by taking first 4 letters of the command when possible.

[4] See footnote 2.

APPENDIX C–Continued

Section III–Continued

OPERATION	POTENTIAL COMMANDS	RECOMMENDATIONS	
		COMMAND	ABBREVIATIONS[3] (4-CHAR)
Define an input or output format	FORM FORMAT INPUT OUTPUT REPORT WRITE	FORMAT	FORM
Delay for stated amount of time	DELAY HOLD	DELAY	DELA
Delete an existing file or set of information	ABORT CLEAR DELETE DESTROY KILL OMIT PURGE REMOVE UNSAVE ZAP	DELETE	DELE
Display index of all files	DIRECTORY DISPLAY FILES INDEX	INDEX	INDE
Display index of all available files	DIRECTORY INDEX	INDEX	INDE
Display the content of a field	DISPLAY LIST SHOW TERMINAL WRITE TO = VIEW W2TO	SHOW	SHOW
Edit a file or set of information	ED EDIT UPDATE	EDIT	EDIT
End action	END	END	END
Enter the system	BEGIN ENTER ID IDENT LOGON SIGNON USER	LOGON	LOGN
Extract portion from file or set of information	EXTRACT	EXTRACT	EXTR
Find designated file	SEARCH SEEK	SEARCH	SEAR
Get system status	STATUS SYSTAT	STATUS	STAT

APPENDIX C–Continued

Section III–Continued

OPERATION	POTENTIAL COMMANDS	RECOMMENDATIONS	
		COMMAND	ABBREVIATIONS[3] (4-CHAR)
Increment a counter	ADD ADVANCE INCREASE INCREMENT	INCREASE	INCR
Indicate a file or set of information to work with	CONNECT DEFINE FETCH FILE FILE = FIND GET LOAD RECALL REQUEST SELECT USE	GET	GET
Indicates type of function needed	INQUIRY	INQUIRY	INQU
Insert new information in file or set of information	INSERT	INSERT	INSE
Leave the system	ABORT BYE DONE END EXIT LOGOFF OFF SIGNOFF STOP QUIT	LOGOFF	LOGF
Lend assistance to operator	HELP	HELP	HELP
Merge data into a file or set of information	ADJOIN CONCATENATE CONNECT JOIN MERGE	MERGE	MERG
Notify user or operator or another terminal of a condition or event	ADVISE APPRISE NOTIFY TELL	ADVISE	ADVI
Page forward	CARRIAGE RETURN FORWARD NEXT PAGE PAGE AHEAD PAGE FORWARD	PAGE AHEAD	PAGA
Page backward	BACK BACKWARD PAGE PAGE BACK PAGE BACKWARD PREVIOUS	PAGE BACK	PAGB

APPENDIX C–Continued

Section III–Continued

OPERATION	POTENTIAL COMMANDS	RECOMMENDATIONS	
		COMMAND	ABBREVIATIONS[3] (4-CHAR)
Print a hard copy	COPY LIST LP = OUTPUT PRINT WRITE	PRINT	PRIN
Print schedule or calendar	CALENDAR SCHEDULE	CALENDAR	CALE
Protect a file or set of information	PRESERVE PROTECT READ SAVE STATUS R	PROTECT	PROT
Select or activate a computer-controlled device	ACTIVATE ACTUATE AFFIX ATTACH CONNECT GO SELECT	SELECT	SELE
Sort data in a file or set of information	ARRANGE ARRAY ASSORT ORDER SEQUENCE SORT	SORT	SORT
Stop print of file or set of information	BREAK DISCONTINUE STOP	BREAK	BREA
Stop temporarily	PAUSE	PAUSE	PAUS
Store a file or set of information on disk	COPY DISK DOUT FILE FILEOUT HOLD KEEP RECORD RETAIN SAVE STORE WRITE WRITE DISK W2DK	SAVE	SAVE
Wait for input	WAIT	WAIT	WAIT
Write a file or set of information on tape	COPY SAVE TAPE TAPEOUT TOUT WRITE TAPE W2TP	SAVE	SAVE

GLOSSARY

This glossary contains rudimentary definitions. One of its purposes is to serve as a reminder that not everyone understands computer jargon. Comprehensive dictionaries such as C.J. Sippl and Roger J. Sippl's *Computer Dictionary and Handbook* (third edition), 1980 are available.

Access time — The time interval between the instant at which data is called for and the instant at which delivery is completed. See also response time.

Accommodation — The ability of the eyes to adjust to or "accommodate" different viewing distances.

Acoustic coupler — A modem that enables a remote terminal to be connected with the central processor using a conventional telephone receiver and by dialing over a public or leased telephone line.

Alphanumeric — Pertaining to a character set that contains both letters and numerals.

Analog Computer — A computer that calculates by constructing an analogy, and measuring answers in the form of voltages, distances, and the like, rather than calculating the answers in a precise mathematical fashion.

Application package — A program or set of programs designed to perform a given function or set of functions, e.g., typesetting, text editing.

Aspect ratio — The ratio between the height and width of the viewing area of a CRT screen.

ASCII — Pronounced "asky". The complete acronym is USASCII, the USA standard data code; the U.S. version of the ISO 7-bit data code.

Associative coding — A type of coding in which a unique code is associated with an item of data, e.g., telephone dialing codes.

Asynchronous data channel — A communication channel capable of transmitting data but not able to time the information.

Asynchronous modem — A modem which cannot transmit timing information in addition to the data; a modem which does not require synchronisation with the associated terminal equipment.

Auxiliary keyset — A separate pad or block of keys, usually numeric, in addition to the main alphanumeric keyset on the terminal keyboard. Usually, but not necessarily, an integral part of the main keyboard.

Auxiliary storage — Any peripheral device, e.g., tape, disc, etc., upon which data may be stored. As opposed to the internal storage capacity of the central computer. See also Backing store.

B

Backing store — An intermediate storage medium, e.g., paper tape, card, disc, etc., onto which data is entered from an off line terminal for later processing by the central computer. Also any auxiliary storage medium.

Baud — A measure of the transmission speed capability of a communications line or system. In a sequence of binary signals, 1 Baud = 1 Bit/sec.

Bin — Colloquial term sometimes used to describe buffer storage in a computer system.

Binary code — A coding system employing the binary digits one and zero to represent a letter, digit, or other character in a computer.

Binary digit — Also known as BASE 2. A number system consisting of two digits; the character ***0*** and the character ***1***.

Bit — The smallest entity in the memory of a computer. The internal language and operations of a computer are based on the binary system. Often described as an "on/off" switch. The combination of the "ons" and "offs" forming a binary pattern for the storage of information.

Board — Printed circuit (PC) board with "chips" used for:

CPU (Central Processing Unit)
I/O (Input/Output)
RAM (Random Access Memory)
ROM (Read Only Memory)
Video (24 X 80 character display or graphics display)
Others

Buffer — *An area of computer memory for temporary storage of an input or output record.*

Byte — A term often used to describe storage within a computer. A BYTE contains 8 or 16 BITS depending on the design of the computer. Computer memory capacity is often expressed as the number of BYTES available. For example, a computer with 16K bytes of memory has about 16,000 bytes available for storing programs and data.

C

Cathode ray terminal, **CRT** — A terminal which has a keyboard for data input and a display screen. Also used to describe a type of terminal in which an electronic vacuum tube energizes phosphors on a screen.

Central processing unit, **CPU** — The computer at the center of an on-line system which performs the processing according to the applications package. Also called host computer. It does all of the calculations and operations which the computer has been instructed to do.

Character — The actual or coded representation of a digit, letter, or special symbol but not a space.

Check bit — A unit within a byte or word of data which is used to check the validity of the data.

Chord keying — A keyboard in which two or more keys must be depressed simultaneously in order to send commands from the keyboard.

Clock — Shorthand term for the source or sources of timing signals used in synchronous data channels.

Clock rate — *The speed or frequency at which the clock oscillator produces control pulses* which schedule the operation of the computer.

Cluster — A data network in which two or more terminals are connected to a line or data channel at a single point.

Code — A system of symbols and rules for use in representing information.

Command — A pulse, signal, or set of signals that occur in a computer as the result of an instruction and which initiate one step in the process of executing the instruction.

Contention — *a condition in the computer system when two or more terminals attempt to transmit data in* a communication line at the same time.

Control character — A character whose occurrence in a particular context initiates, modifies, or stops a function. There are 32 such characters in the ASCII data code.

Control action — An action taken by the user to alter the state of the system.

Control unit — That part of a central or intermediate processor that directs the sequence of operations, interprets the coded instructions, and initiates the proper signals to the computer circuits to execute the instructions.

Core (storage) — The memory or internal storage capacity of a computer.

CPU — See ***Central Processing Unit.***

Critical fusion frequency (CFF) — As the frequency of a flickering stimulus increases, a point is reached where the flicker ceases and the individual sensations are fused into a continuous, uniform sensation. This point is known as the 'critical fusion frequency'.

CRT — See cathode ray terminal.

Cursor — A symbol or sign which acts as a pointer to identify one or more character spaces on the display screen of a CRT which will be affected by a command or action. For example, it may indicate where the next character to be typed will appear

Cursor control keys — Those keys which specifically control the movement of the cursor on a CRT; necessary for editing operations and for rapid access to any part of the display screen.

Cycle time — The length of time used by a computer for one operation, usually measured in micro- or nanoseconds.

D

Data store — The part of a terminal in which received data is held during operation. A method of storing data, usually in binary coded form.

Data transmission. — The automatic transfer of data between two points, usually the computer and a terminal, in a computer system. The data are transferred via a telegraph, telephone, or radio circuit.

Debugging — The technique of problem resolution. Applied to software and application programs as well as total system errors.

Delete — The ability to remove extraneous or erroneous material from screen or memory, simultaneously eliminating the gaps which would otherwise be formed.

Directory — A meaningful list of the contents of a system or system component pertaining to a given parameter, e.g., user's name, subject head, etc.

Disc drive — A peripheral device consisting of record like "disks" of magnetic material for the bulk storage of information. Within the drive the disk spins past the read/record heads at speeds from 200 to several thousand RPM. The faster the speed the quicker the computer is able to access information contained on the disk.

Display coding — A means of highlighting displayed segments such that one segment is differentiated from other segments.

Display memory — The internal storage capacity of a CRT to permit a greater character display capacity than the screen is able to accommodate.

Distributed processing — Data and associated processes (data entry, edit and validation, inquiries, output processing) disbursed from a host computer to generally smaller functionally independent minicomputers.

Downtime — The time during which a computer system is not able to perform functional operations.

Dot matrix characters — Character images on a CRT display screen that are represented by an appropriate number and location of dots within a defined cell or "matrix" of dot positions.

Dynamic display — A display that changes automatically as a result of a system action.

E

Envelope — The part of a total message which is concerned with the control and command of transmission to and from defined destinations of the data message contained within it.

F

Facsimile character generation — The technique of writing characters on a display screen by copying those already written and stored in a master set.

Feedback — A response from the system which informs the user of the status of the current request or command.

File — A collection of related records, usually, but not necessarily, arranged in sequence according to a directory key contained in each record.

Firmwire — Routines wired into the computer as part of the circuitry.

Fixed data — Data that is written on the display screen of a CRT but which cannot be altered by the user.

Fixed function key — A function key that is not readily changeable.

Flicker — A form of image instability caused by the perceived dimming and brightening of the character images as they are refreshed on the display screen. See also Critical fusion frequency (C.F.F.).

Floppy — Flexible diskette 5¼" or 8", capable of storing 50-250 pages of text.

Flowchart — A graphic representation, using standard symbols, which portrays logical data and processing requirements.

Formatting — The structuring of the display screen into protected and accessible areas within which various actions can be performed in fields.

Form filling — The entering of information into pre-defined areas or fields in the display screen. Appropriate for buffered terminals only.

Full duplex — Pertaining to the simultaneous, independent transmission of data in both directions over a communications line. Also called duplex; see also half duplex and simplex.

Function keyset — A collection of keys, each of which is associated with a specific command.

G

Glare — A visual condition caused by excessive luminance variations within the field of vision, e.g., when bright sources of light such as windows or lamps or their reflected images fall in the line of sight.

Grain — The particle size of the phospor coating on the interior surface of the CRT face.

Graphic display — Display of data in the form of lines, shapes, and symbols such as graphs, histograms, maps, etc.

H

Half duplex transmission — The alternate and independent transmission of data in both directions, but in only one direction at a time, over a communication line. See also full duplex, simplex.

Hard copy unit — A printer associated with a processing system which, on command from the operator or program, can print out the information displayed on a CRT screen or contained in storage.

Hardware — The physical equipment which makes up a computer system, e.g., CPU, terminals, and other input/output (I/O) and storage devices. As opposed to the programing software.

Head — A device that reads, writes, or erases data on a storage medium, e.g., the fixed or moving electromagnetic heads used to read, write, and erase data on magnetic discs or drums. Also the set of perforating and reading devices used for punching and reading paper tape.

Header — A series of characters that precedes a message giving addressing, source, and other information concerning the message to follow. The front part of the message envelope carrying the data necessary to allow the system to transmit the message to and from the correct destinations.

Hierarchical — Arranged in a set of levels; tree-structured.

Holding time — The time during which a communication line is in use for transmission.

Host computer — The central computer on which the application program is run. The central computer in a centralized computer network, also called CPU or Mainframe.

I

Illuminance — That part of the luminous flux that is incident on a unit area of a surface, i.e., a measure of the quantity of light with which a surface is illuminated. Measured in units of Lux (lx).

Image stability — The perceived stability, i.e., freedom from flicker and movement, of the character images on the display screen. The main causes of image instability are fluctuations of the voltage supply, (e.g., variation in main voltage, voltage spikes, etc.) scan line jitter, and flicker.

Intelligent terminal — a terminal which incorporates a microprocessor capable of performing processing functions independently of the central processor.

Interface — An electronic device which enables one piece of equipment to communicate with or control another.

Internal storage — The total memory or storage capacity within and controlled by a central processor.

I/O — Input/Output.

Isochronous data channel — A communication channel capable of transmitting timing information in addition to data. Also called a synchronous data channel.

J

Jitter — A type of visual display image instability in which the individual lines appear to oscillate due to too low signal strength or poor synchronisation. Also called line jitter.

K

"K" — A cluster of 1,024 bytes of computer memory. 64K would indicate the ability of the memory to store approximately 64,000 BYTES (characters).

Key travel — The displacement of the key from its static to fully depressed position; also called stroke.

Kinesthetic feedback — Indication that an action has been effected, e.g., the actioning of a keystroke, by the sensation of touch, position, or movement.

L

Languages — Software framework of commands for writing a program.

Latency — The time required to locate the first character of a location in storage; calculated as access time minus work time.

Left-Justify — To display data in columns such that the first character of each row is aligned vertically.

Letter quality printer — A printer which produces output which is similar in quality of type to that of a typewriter. Print elements usually impact on the page and are similar to the "ball" elements on IBM typewriters. The speed of a letter quality is usually a great deal slower than a line printer and should be used only when the extra quality is essential.

Line switching — A method of establishing communication space needed in a switched network, e.g., by dialing, whereby the channel so established remains dedicated to the user for the duration of his "call".

Local terminal — A CRT that is linked directly to a computer or control unit.

LSI — Large Scale Integration (of circuits).

M

Machine language — A language that is used directly by a computer; a "machine language program" is a set of instructions written using a code that the computer is able to identify.

Mainframe — The central processing unit or CPU of a large computer system.

Memory — The part of a computer, internal to the CPU, where programs and data are stored.

Menu — A collection of items, e.g., a list or directory of the contents of a given file, from which the operator may select.

Merge — To combine two or more sets of data into a single set.

Message format — Rules for the placement of parts of a message, e.g., heading, address, text, and end of message.

Message switching — The switching technique of receiving a message or group of messages, storing until the proper outgoing circuit and station are available, and then retransmitting toward their destination.

Microcomputer — A term used to describe the small physical size of a computer. In particular, in today's vernacular, it describes the personal/home computers and a few of the small business computers.

Micromesh filter — A fine mesh that is placed in front of or in contact with a CRT display screen in order to reduce the visibility of reflections on the screen.

Microprocessor — The "chip" or CPU (Central Processing Unit) with I/O (Input/Output) on the same circuit board.

Minicomputer — A computer whose physical size places it between the microcomputer and the full size computers. At today's state of the art, the minicomputer has double the capacity and speed of the large computers of 5-8 years ago.

Modem — a contraction of the term "modulator-demodulator". A device used to convert serial digital data from a transmitting terminal to a signal that is suitable for transmission over a telephone channel, and to reconvert the signal to serial digital data for acceptance by a receiving terminal.

Multi-dropped line — A single communication line to which terminals are attached at more than one point.

Multiplex — To interleave or simultaneously transmit two or more messages on a single data channel.

Multiplexer — A device used to divide a data channel into two or more independent fixed data channels of lower speed.

Multi-point — A line or data channel connecting terminals at more than one point. Sometimes called multi-drop; see also Cluster.

Multi-tasking — The system appears to or actually does run several programs simultaneously, often with "satellite" (slave) processors (separate CPUs).

Multi-threading — The apparent ability of a computer to handle more than one terminal user at any given time.

Multi-user — A system which permits multiple users to access the same system in a time-sharing mode via "time slicing" interrupts of the single CPU or via use of satellite CPUs.

N

Narrative format — A basic, single column display format, i.e., a format lacking in tabular or any other specific type of formatting constraint.

Network — A group of computers interconnected by cables or phone lines.

N-key roll-over — A keyboard characteristic in which the keyboard is able to generate all keystrokes in the correct sequence when two or more keys are depressed at the same time.

Non-erasable storage — Storage media (e.g., punch cards, paper tape) the information on which cannot be erased to permit re-use.

Non-volatile storage — Storage media that retain information in the absence of power, e.g., magnetic drums, tapes, discs, etc.

Numeric keypad — An arrangement of the 10 numeric keys in the standard telephone arrangement, 1,2,3 across top row; 4,5,6 in second row; 7,8,9 in third row; with 0 on the bottom row.

O

Off-line system — A systems configuration in which the input/output devices (e.g., the terminals) are not in direct communication with the central processor.

On-line system — A systems configuration in which the input/output devices (e.g., the terminals) are in direct communication with the central processor.

Operating system — Software routines provided by the manufacturer for interfacing activities of components of the machine (disks, CRTs, printers, and both the editing and running of programs), tailored to each machine.

P

Page scrolling — A technique used in recalling information from the display memory in which, as the information is recalled, the entire screen content is renewed to make room for the new data. Analogous to the page-by-page presentation and indexing of printed information. See also roll scrolling, pan scrolling.

Pan scrolling — A variation of roll scrolling in which the movement of the lines of data up and down the screen is smoother, i.e., less jerky, than the conventional roll scroll and more similar to the smooth panning of the credits following a TV program. True pan scrolling cannot be achieved on a CRT display employing raster scanning but the effect can be approached by roll scrolling at slow speed.

Parity — The condition of the number of items in a group, e.g., bits in a byte, being odd or even. Used as a basis for checking certain types of error in data transmission.

Parity check — The automatic transmission of additional parity bits to enable the receiving device to check the accuracy of the transmitted data.

Password — A word or code used to identify the user of a CRT or computer system. Usually the user has to give the password to access certain data.

Peripheral equipment — The input/output units and auxiliary storage of a computer system, such as disks, printers, CRTs, and modems.

Phosphor — A coating of luminescent material which emits visible light when struck by a beam of electrons within an evacuated glass tube such as a CRT.

Pin cushion distortion — a type of image distortion on the face of a CRT due to the different radii of of the electron beam on the CRT screen. Without correct circuitry, a line drawn across the screen would appear to bow in an arc, the effect being greatest along the edges of the screen. Also called 'barrel distortion'.

Polarization filter — A type of screen filter in which the intensity of the reflection of incident light is reduced through the polarizing action of the filter. That is, only light waves in one plane are allowed to escape the field of the filter. This is one way to reduce glare.

Polling — The interrogation of each terminal in a multi-point or clustered network by the computer to determine whether it is ready to receive or transmit data. This is necessary if data transmission can only be initiated by the computer.

Port — Point of access to the computer for a printer, CRT, or modem.

Portability — A characteristic of software that can be run on different machines, especially different models, with little or no program modifications.

Processor utilization — The amount of time, usually expressed as a percentage of total available time, during which the processor is engaged in performing necessary and useful tasks.

Program — Set of instructions for handling data that is input into the system

LEVELS: a — languages are used to write programs.

b — programs combine to handle a specific application.

Protected field — A designated field on a display screen within which no keyboard initiated action can make any change.

Protocol — A set of rules governing the flow of information within a communication system.

R

RAM — (Random Access Memory) solid-state machine memory or "user work space" independent from external storage devices.

Random access — A system of file management, usually on disc, in which data may be accessed independent of its file location or the location of the data previously accessed.

Raster — The pattern of scan lines traced across the face of the CRT by the electron beam.

Raster scan — A method scanning a CRT display in a series of horizontal lines. The technique used in television receivers and most types of CRTs.

Redundancy — That part of the total information content of a message which can be eliminated without loss of essential information. Also a type of information, the full content of which may be predicted from a knowledge of only part of the total information. In this sense, human language is more redundant than most types of numerical data.

Reflectance — The ratio between the quantity of light that is reflected from a given surface and the total quantity of light that is incident on the same surface.

Reflected glare — A glare condition caused by the reflection of bright sources of light, e.g., windows, luminaires, etc., from illuminated surfaces within the field of vision.

Refresh — A technique used to regularly energize the phosphor coating in the CRT in order to ensure an apparently continuous and stable, but in fact transient image.

Refresh rate — The frequency with which the image on the face of the CRT is refreshed.

Releases — Updated versions of software, often given with decimals, such as Version 1.15.

Remote connection — A connection in which one device, e.g., a CRT, is located remote from the computer system. This generally means that the data connection is via a leased or switched telephone line).

Remote terminal — A CRT with its own refresh store, editing capability and a modem interface.

Response time — The elapsed time between the generation of an inquiry at a data terminal and the receipt of the response at the same terminal.

Right justify. — To display data in columns such that the last character of each row is aligned vertically.

Roll-over — A keyboard characteristic that permits the correct interpretation of keystroke sequence when two or more keys are depressed at the same time; see also Two-key roll-over, N-key roll-over.

Roll scroll — A technique used in recalling information from the display memory in which, as each line of text is recalled, all existing lines on the display screen move up or down by one line to make room for the new line. The movement of the lines of data is discontinuous and similar to the line feed movement of paper in a line printer.

ROM — (Read Only Memory) routines and languages wired into a plug-in circuit card.

S

Screen buffer — The butter from which the display on a CRT is refreshed.

Screen format — The structure or layout of a visual display, e.g., column text format (narrative), tabular, divided into protected and unprotected areas, etc.

Serial data transmission — A method of data transmission whereby data characters or bytes are transmitted one bit at a time over a single path.

Software — The term for all programs that run on the computer.

Stand-alone terminal — A terminal which can be directly connected with a modem, i.e., not one of a terminal cluster.

Stand-alone processing system — A processing system which does not depend on a host processing computer for normal operation.

Start-stop transmission — A method of serial data transmission in which each character or byte is transmitted as a self-contained piece of information needing no additional synchronising or timing information to be transmitted.

System — Computer plus printer-CRTs-modems plus software.

System overload — A condition in which the system has more processing to do than can be done in a given time period.

T

Tabular display — Data presented in row/column format.

Tabulation markers — Symbols used to designate protected fields in the visual display but may also be used as tabulation settings similar to the use of tab settings on a typewriter.

Tactile feedback — Indication that an action has been effected, e.g., a keystroke, by the sense of touch.

Tail — The series of codes that are transmitted with, but immediately after the message to denote end of message; the last part of the message envelope. See also Header.

Teletype-compatible terminal — (TTY) A hardcopy terminal or CRT which is compatible with a teletype either at the functional or software level.

Television (TV) scan — A regular series of horizontal scan lines from the top to bottom of the CRT face. Both line scan and frame rates are defined by international standard, e.g., for a 625 line system.

Terminal — An input-output (I/O) device for transmitting or receiving data on a communication line.

Textual display — A display of data in paragraph form.

Time-critical function — A function which requires immediate attention by a user.

Time-sharing — A function of software that enables parcelling out access to the processor among Input/Output (I/O) devices such as CRTs — often via "dial-up" ports (access).

Transformational coding — A method of data coding in which the data is transformed into coded form by the application of a strict set of transformational rules.

Transposition error — A keyboarding error in which characters are keyed in reverse order.

Two-key lock-out — A keyboard characteristic that inhibits all further keyboard action when more than one key is depressed.

Two-key roll-over — A keyboard characteristic that permits keystroke sequence to be correctly interpreted when the two keys are depressed at the same time.

Typamatic key — A key which automatically repeats the character or function associated with it when the key is depressed for more than a short period of time, typically after half a second.

U

Unit buffer terminal — A terminal which has no communication buffer, e.g., a teletype terminal.

Unprotected field — Any part of a visual display, the structure or contents of which may be altered on command from the CRT operator.

UPS — Uninterruptable Power Supply. A voltage stabilized main power supply to a computer system to safeguard against fluctuations of voltage caused by loading variations at the central power station, switching on and off of heavy items of equipment, weather, etc.

Utilities — Common software routines, such as merging of files, applicable to many different applications and invoked by simple commands.

V

Variable function key — A function key that is readily changeable, e.g., keys that are displayed electronically on a CRT.

Vector drawing — A method of character generation in which the electron beam is steered so that the required character shape is 'written' on the face of the CRT. The beam brightness is also controlled so that only the required strokes are made visible.

VLSI — Very Large Scale Integration (of circuits).

Voice grade channel — A communication channel which is suitable for the transmission of speech, digital, or analogue data. The band width of voice grade channels usually extends from about 300 to 3500 Hz.

Volatile memory — A storage medium on which the information is lost when the power supply is turned off, e.g., delay-line storage.

W

Word — A storage location usually comprising 8, 12, or 16 bits. Two characters, for example, may be stored in one word of a 16-bit computer. In some computers, the principle of chaining is used to achieve longer words.

Word length — The number of bits or characters in a word.

Working level — When operating the keyboard in the seating position, the working level is the distance between the underside of the thighs resting on the seat of the chair and the underside of the hands in the keyboarding posture.

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