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DEPARTMENT OF DEFENSE HANDBOOK

HUMAN ENGINEERING GUIDELINES FOR MANAGEMENT INFORMATION SYSTEMS

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FOREWORD

1. This military handbook is approved for use by all Departments and Agencies of the Department of Defense.

2. Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, US Army Missile Command, ATTN: AMSMI-RD-SE-TD-ST, Redstone Arsenal, AL 35898-5270, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document, or by letter.

3. The purpose of this document is to provide human factors engineering design guidance for the analysis, design, and evaluation of computer based Management Information Systems. Guidance is presented in the form of 1) analysis and design techniques which should be applied to the development and evaluation of User-Computer Interface (UCI) design concepts, and 2), design guidelines which should be used during UCI requirements analysis, design, development, test and integration.

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1. SCOPE

1.1 Purpose. The purpose of this handbook is to provide guidance in the application of human engineering to the design and development of management information (and related) software systems. The users of this document are intended to be any individual, or group, who participates in the development of software systems, including logicians, software engineers, end-system users, software development managers, programmers, system evaluators, and human factors engineers.

1.2 Scope. This handbook provides analysis techniques and methodologies for management information system development and presents human engineering guidelines for detailed user-computer interface software design. Where hardware design guidance is needed, the requirements of MIL-STD-1472 "Human Engineering Design Criteria for Military Systems, Equipment, and Facilities" should apply.

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2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in solicitation.

SPECIFICATIONS

MILITARY

MIL-H-46855B	Human Engineering Requirements for Military Systems, Equipment, and Facilities.

STANDARDS

MILITARY

MIL-STD-12	Abbreviations for use on Drawings, Specifications, Standards, and in Technical-Type Publications.
MIL-STD-411	Aircrew Station Signals.
MIL-STD-490	Specification Practices.
MIL-STD-783	Legends for Use in Aircrew Stations and on Airborne Equipment.
MIL-STD-1472	Human Engineering Design Criteria for Military Systems, Equipment, and Facilities.
MIL-STD-2167	Defense System Software Development.

HANDBOOKS

MILITARY

MIL-HDBK-759	Human Factors Engineering Design for Army Material.
MIL-HDBK-763	Human Engineering Procedures Guide.

2.2 Non-Government publications. The following document(s) form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DoD adopted are those listed in the issue of the DODISS cited in the solicitation. Unless otherwise specified, the issues of the documents not listed in the DODISS are the issues of the documents cited in the solicitation.

AMERICAN NATIONAL STANDARDS INSTITUTE

ANSI/HFS 100-1988	Visual Display Terminal Workstations.

2.3 Order of precedence. In the event of conflict between the text of this handbook and the specifications and standards cited herein, the text of standards and specifications should take precedence. In the event of conflict between the text of this handbook and military handbooks cited herein, the text of this handbook should take precedence.

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3. DEFINITIONS

3.1 Definition of terms.

3.1.1 Management information system. A system which may perform routine processing functions, but which is designed so that processing will produce information that will assist in decision making. Real-time processing of information is frequently required in management information systems.

3.1.2 Human engineering. A technical discipline which exists to optimize overall system performance through development of compatible interactions between the human and the system, in order to reduce human contributions to system unreliability, non-availability, and mission failure.

3.1.3 User-computer interface. The modes by which the human user and the computer communicate information and by which control is commanded, including areas such as: information presentation, displays, displayed information, formats and data elements; command modes and languages; input devices and techniques; dialog, interaction and transaction modes; timing and pacing of operations; feedback, error diagnosis, prompting, queuing and job performance aiding; and decision aiding.

3.2 Abbreviations and acronyms used in this handbook. Definition of abbreviations and acronyms used in this handbook are as follows:

- CPU - Central Processing Unit
- CSC - Computer Software Component
- CSCI - Computer Software Configuration Item
- FCA - Functional Configuration Audit
- FQR - Formal Qualification Review
- HE - Human Engineering
- HFE - Human Factors Engineering
- I/O - Input/Output
- JPA - Job Performance Aid
- MIS - Management Information System
- PCA - Physical Configuration Audit
- PDR - Preliminary Design Review
- SRR - System Requirements Review
- SDR - System Design Review
- TRR - Test Readiness Review
- UCI - User-Computer Interface
- VDT - Visual Display Terminal.

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4. GENERAL GUIDANCE

4.1 Design process.

4.1.1 Overview. DOD-STD-2167 Defense System Software Development describes the software development process and the significant activities required in each phase of that process. DOD-STD-2167 does not specifically address the development of the user-computer interface in conjunction with the development of system software, however, a process for developing and evaluating UCI for a software system should be closely integrated with the process for overall software development. UCI design will place additional requirements and constraints on overall software design. Therefore, the design of UCI must be integrated into the software development process. As defined in DOD-STD 2167, the major phases in the software development process, and the reviews conducted at the termination of each phase, are as follows:

a) System concept development - system requirements review
b) System requirements analysis - system design review
c) Software requirements analysis - software specification review
d) Preliminary design - preliminary design review
e) Detailed design - critical design review
f) Coding, unit testing and computer software component integration testing - test readiness review
g) System integration and testing (including computer software configuration item testing) - functional configuration audit , physical configuration audit, and formal qualification review.

UCI incorporates all system design features and provisions which enable and enhance the interactions between the system user and software. These include: displays, displayed information, formats and elements; command modes; user-interface language; input devices and techniques; dialogs, interactions and transactions between user and computer; user feedback; decision aiding; procedures and user documentation; and provisions for training, prompting, cueing, helping, tutoring, and job performance aiding. The objective of the UCI design process is to describe a standardized and formalized approach to the design of user-computer interfaces which, used in conjunction with the guidelines in Section 5 of this Handbook, will result in a UCI approach which is maximally usable, operable, reliable and fully integrated with the system and software development processes.

The basis of the approach in the UCI design process is to identify user requirements and UCI design concepts and criteria, and to integrate these with the overall software development effort. The UCI design process consists of three distinct phases: requirements analysis, UCI design and development, and UCI test and integration.

The primary products of the UCI design process are the outputs of each of the process phases. These are: a functional specification, describing the requirements which the UCI design will address; a design specification describing the design approaches to be taken in UCI design; an implementation specification, describing how the UCI must be implemented; and UCI test and evaluation plans and reports.

4.1.2 Description of the UCI design process. Figure 1 presents the overall UCI design process integrated with the overall software development process as outlined in DOD-STD-2167.

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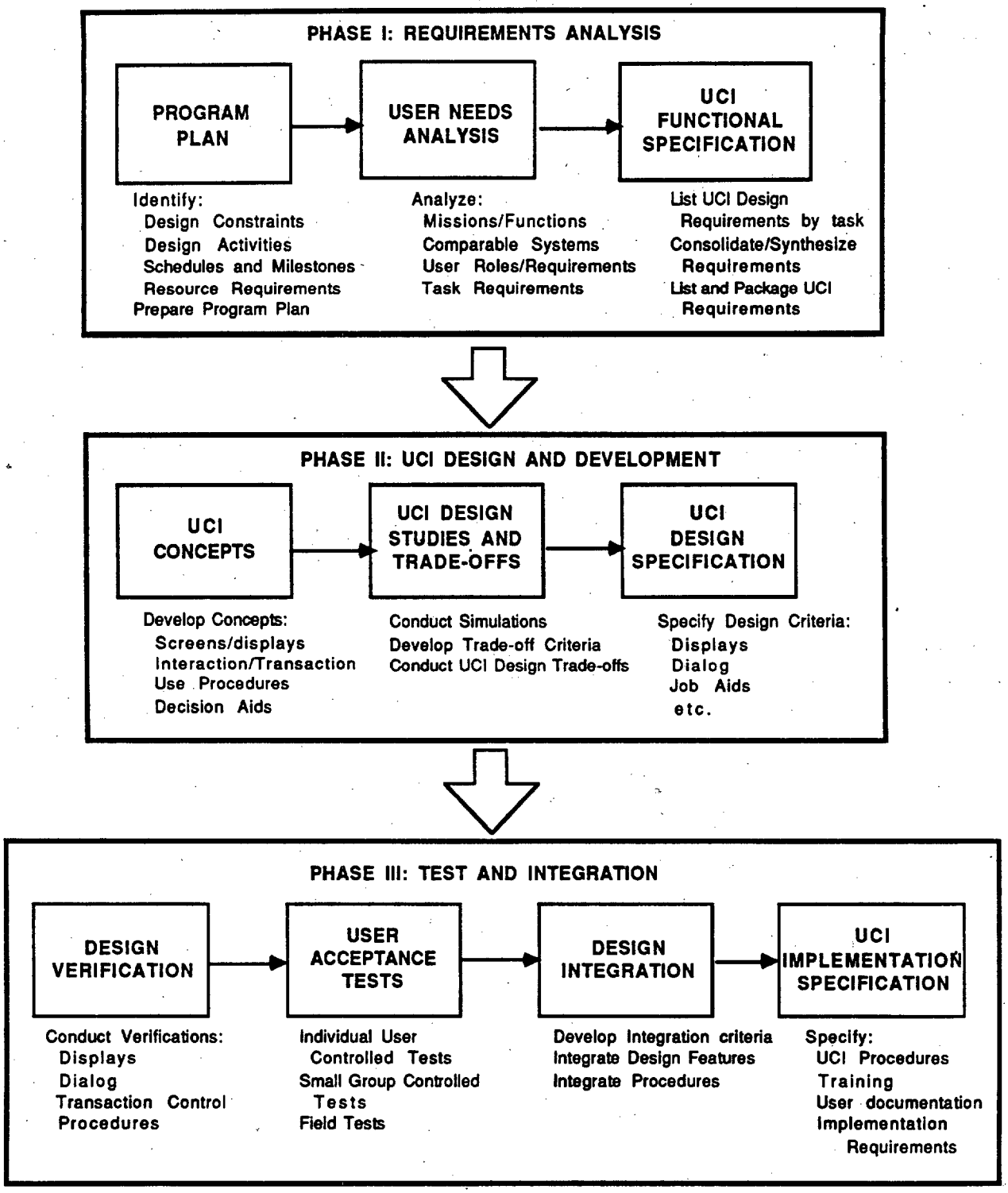

FIGURE 1. User-computer interface design process.

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4.1.2.1 Phase I: requirements analysis. The objective of this phase is to produce the UCI functional specification, which contains the set of requirements which the UCI design approach will address. During this initial Phase the UCI Design Program Plan is prepared and published. When the plan has been implemented, the next step is the conduct of the user requirements analysis, which is primarily concerned with defining system, user, function and task requirements. Lessons learned from existing systems are examined to identify pitfalls to be avoided and effective design approaches to be continued in the emerging system. Based on the set of requirements and lessons learned, specific functional requirements for the UCI will be developed in terms of the capabilities which the UCI must possess in order to support the performance of each task. These functional requirements will form the basis for the UCI functional specification. The major products of this phase are the lessons learned, user tasks and task requirements, and the UCI functional specification, keyed to user tasks. Activities in this phase of UCI development are conducted in the System Concept Development and System Requirements Analysis Phases. The UCI functional specification will serve as an input to the system segment specification, the operational concept document and the preliminary interface requirements specification. The importance of Phase I for UCI design is that successful completion of Phase I activities will ensure that: user requirements and capabilities are considered early in the system design effort; UCI implementations will be usable by the range of intended users; and the resulting system design will be more operable, more reliable, current, usable, and affordable.

4.1.2.1.1 UCI design task 1 - prepare program plan

a) Objective. The objective of this step is to describe the process for producing a program plan for the UCI design effort.

b) Approach. The approach to developing a UCI design program plan involves the following efforts:

1) Identify UCI design activities applicable to each phase of system development, relying on this description of the UCI design process and its associated design activities.

2) Identify schedules and milestones associated with the conduct of the UCI design activities. Schedules will be adapted from the overall system development schedule and will be associated with the software development activities. Milestones will be the specific steps of the UCI design process.

3) Identify required resources, including data, funding, instrumentation, computer resources, special facilities such as rapid prototyping capabilities, and personnel, by area of expertise, who will participate on the UCI design team. Areas of expertise should include human factors engineering, computer programming, engineering, and user requirements determination.

4) Produce the program plan addressing each phase of system development.

c) Product. The UCI Design Program Plan and specific inputs to the software development plan.

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4.1.2.1.2 UCI design task 2 - user needs analysis

a) Objective. To identify, analyze and integrate user requirements which will drive UCI design .

b) Approach. The activities to be conducted in the user needs analysis are as follows:

1) Analysis of missions and functions - Missions will be identified and a mission profile will be constructed. This profile will segment the mission into discrete and well defined mission phases. Mission conditions will be described which will include, at a minimum, operational conditions such as normal, contingency, and emergency operation. For each mission phase under each mission condition, a sequence of top-level functions will be identified. These functions include the actions, and sequence of actions, required for the system (user, hardware and software) to complete each mission phase. The functions will be iteratively analyzed to lower levels of specificity. An example of a UCI functional analysis form is presented as Figure 2. Table 1 contains descriptions and examples of the type of data to be entered in using this form.

2) Comparability analysis - UCI designs implemented in existing systems performing the functions identified above will be assessed. UCI lessons learned will include: problems with UCI usability; positive aspects of the UCI design which should be retained; and lessons learned in UCI design, development and implementation.

3) Role of the user analysis -System functions will be assessed and criteria developed, b based on human and machine capabilities and limitations, to determine which should be automated, which should be manual, and which should require an interaction between user and software. The role of the user addresses the human performance requirements for all functions.

4) Task analysis -For each mission and function under each mission condition, user tasks and task sequences will be identified. Task requirements will be identified as: information requirements - information required to support the performance of each task, and characteristics associated with the information; performance requirements - criteria for each task, such as accuracy limits, time constraints, workload limits, required throughput, and error tolerances; decision requirements - decisions, decision rules, options and feedback requirements associated with the performance of each task; support requirements - support required from system resources to complete the task. An example of a UCI task analysis form is presented as Figure 3. Table 2 contains descriptions and examples of the type of data to be entered in using this form.

c) Products. The products of this step are: lessons learned which will influence the design of UCI, analysis and allocation of functions to user or automated performance or to interaction between the user and the computer, user requirements, and user tasks, task sequences and task requirements.

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Mission/UCI Session Phase:	Function:	Condition:						
Subfunctions	Sequential Operations	Functional Dependencies	Frequency	Mission Criticality	Allocation		Gross User Tasks
					User	System	

FIGURE 2. Example UCI functions analysis form.

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TABLE 1. Description of data fields and entries in using UCI functions analysis form.

• Mission/UCI Session Phase	Identifies the major level phase or UCI sequence for which the remainder of the functions analysis data is appropriate. Examples include; log-on, air-search (in an anti-air system), data form entry (in a data base management system), etc.
• Function	Identifies the system function which will be analyzed. Examples include; initialize system, control air search/radar sweep area, data entry and storage, etc.
• Condition	Specifies the operational conditions under which the function will be analyzed. Examples include; degraded radar penetration due to environmental conditions, wartime ops, peacetime ops, etc.
• Subfunctions	Identifies subfunctions which are subservient to the high level function being analyzed. Examples include; user authentication at time of log-on, control/selection of data formats, monitoring, pacing and control of data input, etc.
• Sequential operations	List of sequential human and computer operations in the conduct of functions and subfunctions. Examples include (for a log-on procedure): power terminals, select and load software, access data, authenticate user access, and so on.
• Functional Dependencies	List of operations and functions which are functionally dependent. For example, data access may be dependent upon authentication of users, while saving or resaving a file may not be dependent upon intervening data changes or updates.
• Frequency	Estimation of the frequency of subfunctions and operations within the accomplishment of a high level function. For example, user authentication may occur once per session (or more frequently for highly sensitive operations), file updates every 5 minutes, etc.
• Mission Criticality	Estimation of the criticality of subfunctions or operations success or failure upon the overall accomplishment of the high level function, or overall system mission. At this time criticality is simply assessed as high, medium, or low.
• Allocation	A preliminary statement of function allocation. For example, user authentication will be allocated to both the human (expression of password, etc.) and the machine (granting access based on password entry), specification of files to be manipulated would be allocated to the user, etc.
• Gross User Tasks	A preliminary list of high level user tasks in accomplishing subfunctions and operations. Examples include; select file to be manipulated (from menu, paper procedures, etc), enter password, input required radar sweep area and speed, etc.

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Mission/UCI Session Phase: | Function: | Task:

Subtask	Mode	User Info Required	Mediation/ Decision Rules	System Info req'd	Automated Support	Control/ Input	Input Type/ Mode	System Response Time	Feedback-Display	Potential Errors-Impacts

FIGURE 3. Example of UCI task analysis form.

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TABLE 2. Description of data fields and entries in using UCI task analysis form.

• Mission/UCI Session Phase	Identifies the major level phase or UCI sequence for which the remainder of the functions analysis data is appropriate. This restates data from the functions analysis form.
• Function	Identifies the system function which will be analyzed. This restates data from the functions analysis form.
• Task	Specifies the operational task which will be analyzed, as indicated on the functions analysis form.
• Mode	Specifies any modes of operation under which the task may be performed or is appropriate. For example; display mode, data input mode, semi-automatic mode, etc.
• User Info Required	Information required by the user to conduct the task, or to direct the system. For example; password, file name, data types, etc.
• Mediation/ Decision Rules	Information and rules applied to decision making in the conduct of decision tasks. For example, data accuracy requirements, decision authority, warfare doctrine, etc.
• System Info Required	User required information regarding the status of the system and for its use. For example; operating system in use, equipment availability (such as printers, sensors and the like), etc.
• Automated Support	Task elements which may be, or must be, supported by machine processing. For example; on line calculators, data conversion software, data extrapolation/interpolation support, and so on.
• Control/ Input	Requirements for user control/input. For example, processing interrupts, directing file operations, and control methods.
• Input Type/ Mode	Type of data to be input or type of control to be executed. For example; discrete vs continuous data input or control.
• System Response Time	Estimation of allowable system response time to user control/input actions, based on system performance requirements. For example, time to solve weapons direction problems in a tactical weapon system.
• Feedback/ Display	Feedback required for operator actions and commands. For example, status of machine processing (messages, graphics, etc.) or problems encountered by the system in command execution.
• Potential Errors - Impacts	Prediction of likely and plausible errors and their impact on mission/ task/function completion. For example; failure to remember password, selection of incorrect control options, etc. Error likelihood might be expressed as high, medium, and low. Impacts would be literal statements such as "delay in data access."

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4.1.2.1.3 UCI design task 3 - prepare UCI functional specification.

a) Objective. To produce a functional specification of the UCI to be designed in phase II. The objective of the UCI functional specification will be to guide the process of developing design concepts and criteria for UCI.

b) Approach. The functional specification will be developed in three basic steps. The first step involves the identification of UCI design requirements by user task. In the second step the requirements will be integrated and collapsed under UCI elements. Requirements generated from user tasks will be allocated to specific UCI design categories, such as: displays, input devices, user-interface language, procedures and documentation, and provisions for training or help functions. Finally, these requirements will be packaged into a UCI functional specification.

The functional specification should address the capabilities which the UCI must possess and the requirements which the UCI design concept must satisfy. It should address what the UCI must do, and what it must be capable of doing.

The specification should: 1)be readily understood, 2) be precise in describing the behavior of the system for each input, 3) be easy to check for consistency, 4) express system behavior with a minimum of complexity, 5) describe the behavior of a UCI without constraining the manner in which it will be implemented, and 6), be closely related to the users mental model of the system.

The UCI functional specification should provide inputs to the system segment specification, the operational concept document and the preliminary interface requirements specification, all of which are developed in the Systems Requirements Analysis Phase of the software development process. The specification should also support a description of the UCI requirements to be presented at the System Requirements Review and the System Design Review.

c) Product. The UCI functional specification.

4.1.2.2 phase II - UCI design and development. The objective of Phase II is to produce a UCI Design Specification document containing performance criteria for the recommended user-computer interface. The functional specification resulting from Phase I will serve as the initial source of input to the UCI design effort. Based on the user requirements, functional allocations and UCI lessons learned contained in the functional specification and software constraints derived from the software development activity, a number of alternative UCI design approaches will be defined. These approaches include concepts for overall UCI design, as well as concepts for design of specific UCI elements.

The conceptualization process will be supported by the implementation of UCI design studies such as rapid prototyping approaches to defining and refining UCI design concepts. Results of these studies will input to the development of tradeoff criteria, and will include software constraints, system, task and user requirements, and of lessons learned analyses. Candidate concepts will be compared by means of tradeoffs and a UCI concept will be selected. Additional studies will be conducted to derive design criteria for the selected concept. Finally, the definition and description of the selected concept and associated design criteria will comprise the UCI design specification.

The products of this phase are a proposed design concept and design criteria and a UCI design specification which will be used to guide the design of the selected concept. The UCI design activities will proceed in parallel with the preliminary and detailed design phases of the software development process. The overall UCI design concept will be developed in conjunction with the preliminary design phase, and will be available for assessment at the preliminary design review. The design concepts for UCI elements will be developed in conjunction with the detailed design

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phase and will be assessed in the critical design review.

4.1.2.2.1 UCI design task 4 - develop UCI design concepts.

a) Objective. The objective of this step is to develop alternative UCI design concepts.

b) Approach. The steps required in the development of UCI design concepts are as follows:

1) Develop screen display concepts: Requirements driving the design of displays, in terms of the overall design concepts as well as concepts for display elements, will be established. Concepts for display organization, coding, layout and format, and inter-screen relationships, will be developed for specific user tasks and task sequences, driven by task requirements. Concepts for overall display approaches and display elements will be developed in an iterative manner beginning with paper simulation, which defines the UCI requirements associated with each user task. Concepts for display elements will be developed by means of display drawings included into the task sequences of the paper simulations. Concepts will be refined and completed by rapid prototyping simulation, described in the design development simulation step of task 5.

2) Develop interaction/transaction concepts: During paper simulations, requirements will also be developed for dialogs between the user and the software. Interactions will be defined as specific exchanges of information, command, or support between user and computer associated with the conduct of each user task. Transactions include the specific data input, display, manipulation, dissemination, processing, retrieval or storage activities associated with each interaction. Concepts for interactions will be developed primarily in the preliminary design stage of software development. Concepts for transactions will be developed in the detailed design phase.

3) Develop concepts for procedures and decision aids: The paper simulations, when completed, will serve as the basis for defining concepts for user procedures and decision aids.

c) Product. Products of this task are UCI design concepts.

4.1.2.2.2 UCI design task 5 - conduct design studies and tradeoffs.

a) Objective. To perform a preliminary evaluation of the proposed display design concept, and identify the constraints of system development and implementation which serve as boundaries around the various design solutions.

b) Approach. An iterative approach to design concept selection is proposed based on the following three steps:

1) Conduct design development simulation. Design development simulations are conducted for three separate objectives: a) to support the development of UCI design concepts; b) to provide user performance data for individual design concepts which serve as inputs to tradeoffs of alternate concepts; and c) to define design criteria associated with selected UCI concepts. Design development simulations include paper simulations described in task 2.1, table-top walkthroughs of user tasks with associated display drawings, and rapid

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prototype evaluation tools including provisions for mocking up, assessing and modifying displays, protocols, dialogs, decision aids, data input, and training provisions.

2) Develop tradeoff criteria. Criteria for evaluating the relative merits of alternate UCI design concepts will be developed based on expected user capabilities and needs, empirical data on representative user performance, system and task requirements, lessons learned, and software constraints.

3) Conduct UCI tradeoffs. Alternative UCI design concepts, at the overall UCI level and at the level of UCI elements, will be evaluated on the tradeoff criteria. When UCI concepts have been selected, additional studies will be conducted to develop design criteria associated with individual design concepts.

c) Products. The product at the conclusion of this task will be selected UCI design concepts and associated design criteria.

4.1.2.2.3 UCI design task 6 - prepare UCI design specification.

a) Objective. To produce a design specification that documents the UCI design criteria.

b) Approach. The UCI design specification will address:

1) Display design. Data on information content, organization and format, user tasks, inter-screen relationships, and display elements.

2) Input device design. Data on data input, manipulation, and modification.

3) Interactive dialog design. Including interactions between user and software, and specific transactions which enable the interactions.

4) Decision aid design. Data on techniques to support the decision-making process of the user, ranging from overlays to artificial intelligence.

5) Procedures design criteria. Data on sequences, subroutines, task dependencies, procedural constraints, and user documentation.

6) Training design criteria. Data on tutorials, help functions and instruction.

7) Maintenance criteria. Data on procedures required to maintain, repair, and update the UCI system.

c) Product. A UCI design specification containing criteria for UCI design and development.

4.1.2.3 phase III: UCI test and integration. The objective of this phase is to formally evaluate the UCI design concept, complete the integration of the UCI with system software, and produce the UCI implementation specification, which contains the requirements for actual implementation of the UCI within the system. During this Phase the UCI design will be tested and fully integrated with system software. Design verification simulations will be conducted which are similar to the design development simulations described in task 2.3. When the specifics of the UCI design have been verified, user acceptance tests will be conducted to ensure that the UCI approach and elements meet

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user expectations and mission needs while meeting acceptance criteria for complexity, ease of learning, retention, transparency, directiveness, and user workload. UCI design approaches will be integrated with
system software, and with UCI of associated systems. In addition, requirements for UCI implementation will be established and packaged in a UCI implementation specification. The major products of this phase are the verification and validation of the UCI design, integration of the UCI with system software, and UCI implementation criteria. Activities in this phase of UCI development are conducted in the system Test and integration phases of software development. The UCI implementation specification will serve as an input to the software test description, operations and support documents, system integration test procedures, and the software product specification.

4.1.2.3.1 UCI design task 7 - conduct design verification.

a) Objective. This step addresses the verification of the selected UCI design approach prior to formal user acceptance testing.

b) Approach. This step will employ rapid prototyping methodologies to simulate and evaluate the effectiveness of the selected UCI design concept. Requirements associated with the conduct of design verification simulation include the following: selection of missions, mission conditions, functions and tasks to be simulated; and the identification of performance measures. Requirements also include: the identification of standards of performance or performance criteria against which performance data are compared, based on task and system requirements; identification of requirements for data and for data acquisition and recording; and identification of simulation methods which includes concerns for simulation fidelity and experimental control.

c) Products. Results of design verification simulations.

4.1.2.3.2 UCI design task 8 - conduct user acceptance tests.

a) Objective. Conduct user acceptance testing of the design of the selected UCI design concept.

b) Approach. During this step, the UCI design concepts verified in the previous step are tested to ensure that the interface satisfies the user defined requirements. The goal of acceptance tests is to force as much of the evolutionary development as possible into the pre-release phase, when change is easy and relatively inexpensive. In conducting the acceptance tests the effort will proceed systematically through the following three stages.

1) Individual user controlled tests. This is an informal evaluation in which a representative user attempts to use the system in a rapid prototyping mode. During this stage there is interaction with the UCI designers concerning difficulties encountered. At the conclusion of the session, the user describes difficulties encountered in attempting to use the interface.

2) Small-group evaluation. During this next stage of evaluation, a group of potential users attempts to use the system with minimal intervention from UCI designers. Errors and difficulties are noted, and the system is redesigned in an attempt to remove these problem areas. The test methods include subjective attitude questionnaires, structured interviews, and objective on-line performance assessments to isolate problem areas requiring interface redesign.

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3) Field evaluation. In this stage, which is also referred to as beta testing or site testing, the system is field tested to simulate the actual training and work environment. During this stage objective user performance data are collected to ensure that software and user interfaces are subjected to a thorough evaluation. This evaluation should ensure that the system is satisfactory for all missions for which it was designed. While a rapid prototyping methodology is acceptable to simulate system operations and user tasks in earlier stages of user acceptance testing, the field test should employ actual software, hardware and procedures.

c) Products. Results of user acceptance tests, and requirements for UCI design modifications.

4.1.2.3.3 UCI design task 9 - integrate UCI and system software.

a) Objective. To integrate the elements of the UCI into system software to support user information requirements, decisions and transactions.

b) Approach. This step will begin with the development of integration criteria. These criteria will address such issues as: what integration is required? How much integration is needed? How should the integration be achieved? The integrations of primary concern include: the integration of software and user interfaces; the integration of different software subroutines with user procedural subroutines; the integration of different display screens; the integration of user interface transactions and mission oriented tasks; and the integration of displays, transactions, dialogs and user procedures.

The integrating activities should be accomplished iteratively with design verification tests and user acceptance tests to ensure that the integration process does not adversely affect the usability of the graphic interfaces.

c) Products. Results of design integration efforts.

4.1.2.3.4 Task 10 - develop the UCI implementation specification.

a) Objective. To define requirements for UCI implementation, and to prepare an implementation specification.

b) Approach. This step begins with requirements for UCI procedures, based on required transactions between user and graphic interfaces, and also based on user tasks and task sequences.

Based on procedures, training requirements will be developed. Training requirements are of three types: job requirements, course requirements, and training system requirements. Job requirements include tasks to be trained and training objectives. Course requirements include determination of the training course content. Training system requirements include determination of training methods, media, materials, measures, and training management requirements.

User documentation will be developed based on procedures and training requirements. User documentation includes hardcopy procedures, instructions and advisories as well as on-line help, user prompts, augmented feedback and tutorials.

UCI implementation requirements include requirements for interrelating user interfaces with procedures, training and user documentation, and guidelines for software developers concerning design criteria associated with specific interface concepts. These guidelines will identify the extent to which an interface must adhere exactly to the criteria, and to what degree can it deviate from the criteria to facilitate the programming effort.

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The UCI Implementation specification will embody the guidelines concerning integration of user interfaces with procedures, training and documentation, and also the guidelines addressing the limits to which the interface design criteria must be strictly enforced.

c) Product. the product of this step is the UCI implementation specification, describing user transactions, procedures, training, documentation, interrelationships among these elements, and guidelines on implementation of the graphic interfaces.

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4.2 General approach to rapid prototyping.

Existing guidelines generally are not able to resolve interface design issues that are context sensitive, such as selecting the proper dialog technique for a specific group of users performing a particular task. In most interface design projects, this problem can be obviated through the application of interface prototypes.

In a basic form, a prototype can be a simple screen image or a drawing of a single display screen, showing the location, coding, information characteristics, etc., of interface elements. More sophisticated prototypes emulate more of the dynamic characteristics of the user interface, and are usually displayed on a graphics terminal. The prototyping process is evolutionary, and therefore, prototypers should provide rapid prototype development which will change with use in designing, developing, and evaluating the interfaces emulated.

4.2.1 Levels of prototyping.

The prototypes presented here are considered in three levels, corresponding to levels of sophistication in emulating the UCI under development:

a) Static prototypes. These allow evaluation of sets of displays pages, formats for data, arrangements, coding, etc. in a static mode. The media for presentation of static prototypes may be static displays on a VDT, or paper images presenting display windows, colors, representative sizes, etc. Paper versions may be included in surveys for purposes of review and annotation. Static prototypes are primarily used for the identification and resolution of design issues, and for the conduct of design tradeoffs. Tradeoffs conducted may address the fundamental nature of the interface, for example use of menu vs command driven dialog.

b) Dynamic prototypes. These allow evaluation of a rough model of the system on a graphics workstation or terminal. A subset of the dynamic characteristics of the developing interface should be provided by this prototype. Dynamic characteristics should include, paging among displays, presentation of menus, help screens, prompts, limited data input and editing, and so forth. Other dynamic characteristics should be simulated for design elements which may be critical to human performance and which may be resolved through dynamic prototyping. Dynamic prototypes should be used to: conduct design tradeoffs at a more detailed level (e.g., level of menu hierarchy depth vs. breadth) than static prototypes; to generate detailed design concepts; and to validate design in terms of meeting performance requirements.

c) Robust prototypes. These should be relatively complete in terms of accurately simulating the dynamic characteristics of an interface. Robust prototypes should provide near perfect fidelity with the actual system interface, including simulation of characteristics such as presentation of error messages, system response times, display code status changes, data entry, editing and recall, etc. Robust prototypes should generally be used to validate design and accomplishment of design objectives, and may be used to perform design tradeoffs at a detailed level (for example, comparing different sequences for advancing among data fields with a form).

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As the general case, the level of sophistication of the prototype should advance through the user-computer interface design process. During the early stages of interface design development, static prototypes will likely be used to evaluate general UCI concepts for areas such as information density, display arrangements, dialog mode, help displays and the like. As the design concepts become increasingly more detailed, dynamic, then robust prototypes should be used to further evaluate interface concepts in a more behavioral, interactive context. The steps in the human engineering software development cycle, such as user needs analysis and task analysis, that take place prior to, and concurrent with, the prototype process are crucial to prototyping. The information and data gathered during the task analysis and the specification of the user requirements contribute key data throughout the prototype process. Utilizing prototyping technology must be in conjunction with the full user-computer interface development cycle. The discussion presented in this section assumes that most, if not all, of the Phase I activities presented in section 4.1 are complete, that general UCI concept formation has begun in accordance with Phase II, and that the capabilities and limitations of the end system hardware are used in constraining the capabilities of the rapid prototyping system to be used.

4.2.2 Human engineering techniques and methods used with prototypes.

Techniques available for gathering user data vary with respect to accuracy and utility of the data collected, the amount of time to apply the technique, and the number and skill level of users that must participate. In addition, certain techniques will be more appropriate at specific phases of prototype development. In all cases, the objective in applying the techniques is to evaluate and refine the user-computer interface in terms of meeting the needs of the user and accomplishing the system mission. Methods and techniques to extract user data using prototyping tools include; DOD-HDBK-763 Human Engineering Procedures Guide, direct observation, performance of pilot studies, human subject experimentation, user interviews, and automated data collection during a prototyped user-computer interface session. Each of these is briefly introduced below.

4.2.2.1 User data and interviews.

As a general case, UCI development represents an evolution of previous MIS/UCI systems (for example, the evolution of sensor systems and combat directions systems with associated tactical displays, situations displays, and the like). User data may be collected even though the details of the interface to be designed are not yet known or specified. In this sense, user data should be collected using precedent systems users, soliciting their experiences and insights, and observing interface behaviors using either or both the precedent systems or prototyped conceptual interfaces of the systems under development.

User data and information which will support the rapid prototype process, and should be identified, includes: 1), existing systems and task experience such as terminology; spatial and movement compatibility; knowledge structures; natural task solutions; statistics; evaluation of existing (competitive) systems; performance on existing systems; ratings of task difficulty; job aids, and 2), planned system considerations such as ratings of icons, graphics and text formats; data input, editing and control requirements; performance times and errors; dialog and command modes; data forms and formats/arrangements; job aiding; error diagnosis, etc.

During interviews, discussions are held with the intended users of the interface to clarify the users needs for this system. This process takes place after the Phase I activities, and requires task descriptions, functional specifications, estimated task performance time and frequency data, error

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information, task difficulty information, and the skills and knowledge required to perform the tasks. Interviews should involve gathering information to help the designer and the user translate task analysis and functional requirement specifications into user interface needs. Interview techniques which can be used at this stage including individual interviews, group discussions, questionnaires, rating forms, free-recall techniques, and sorting techniques. These techniques can be used with any of the prototypes presented above.

4.2.2.2 Direct observation.

Direct observation entails viewing of users during task performance using an actual or prototyped system. Videotaping task performance is included in this category. Direct observation should be used to gather a range of descriptive data about the user-system interaction, to perform activity sampling of task frequency and duration, and to identify problems with existing interfaces.

This form of data gathering requires that the users be present at the site of the prototype or system being evaluated. It also requires a fair amount of time on the part of the users as well as the designers. One of its main advantages is that direct observation is likely to yield findings which may not be easily obtained by other methods. In many situations it is advisable to observe user-system interaction while the user narrates/annotates the session. Data to be identified during these "talking sessions" include normally not observable behaviors such as user goals/intentions, visual references, cognitive approaches to the interaction, problem solving strategies being employed, user expectations regarding system processing and response, timing and phasing of transactions (as in a users stating a waiting interval for an expected system response, or user cognitive process in generating a transaction approach, etc), and user uncertainties and their approaches to reduce uncertainty. Direct observation generally should be used with dynamic and robust prototypes.

4.2.2.3 Pilot studies and experiments.

Pilot studies should be used to evaluate attributes of stimulus materials that will be used in an experiment, to compare design alternatives, and to conduct informal studies were there is no formal hypothesis testing, well defined variables, or statistical testing of data. Descriptive statistics, however, should be generated, such as mean response times of both the equipment and the user, mean throughput time, and minimum and maximum throughput time. Any errors which occur during pilot studies should be noted. There are a range of procedures normally utilized during experiments that can be run as a pilot study. These procedures include free-recall tasks, sorting tasks, rating tasks, as well as measurable performance tasks

An experiment should be designed and conducted where it is required to test a hypothesis or hypotheses, when there are critical interface choices with clearly defined variables, and when the design team needs to compare the performance on alternative interfaces for given task/mission critical sequences that have not been adequately analyzed. The data collected from an experiment should be analyzed with parametric statistics, should conform to the principles of experimental design, and should lead to specific decisions regarding UCI design.

Pilot studies and experiments should generally be used with dynamic or robust prototypes.

4.2.2.4 Surveys.

Surveys provide a way to obtain user preferences, ratings, opinions, or data on an interface. Surveys can be conducted in a number of different modes including on-line, written, face to face interviews, and group discussions. The survey has the advantage that it can be anonymous and

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therefore may elicit more subjectively true opinions and ratings. With a large sample, survey data can be analyzed statistically. Surveys can be used to gather user ratings on some important dimensions of interface design. Surveys can be designed to have users rate their preferences, and requirements for the new interface. Surveys can also be used to have users rate prototypes as well as existing systems. When a written survey is being conducted, a relatively large sample of the user population can be surveyed inexpensively. These written surveys do not have to take up much of the users time, so they can be an efficient way of gathering data. Surveys may used with static, dynamic or robust prototypes.

4.2.2.5 Continuous data collection.

Automatic collection of user data can be accomplished on prototype systems, existing systems, and completed versions of the new system. A range of user data can be collected, including error rate data, frequency and length of on-line help requests, number of system error messages, and throughput and time-on-task data.

The advantage of this technique is that it is nonintrusive. One limitation is that software is required to run in the background, thus limiting application of this technique to the rapid or robust prototype as well as the finished system. This technique normally gathers large amounts of data so that the design team may gave the problem of performing data reduction prior to the analysis.

Continuous data collection should only be used with robust prototypes, unless performance measures are selected which are appropriate for the specific limitations of a lower fidelity prototype (for example, some error data may be appropriate, but timed measures probably will not be appropriate with something less than a robust prototype).

4.2.3 Use of prototypes.

4.2.3.1 Use of static prototypes.

Static prototypes should be used for evaluation of UCI interface which are stable in display presentation, and are not specifically related to time dependent operations (such as data searches, peripheral device operations, etc.), transitional transactions (such as mode changes), or data exchange/handling operations (such data input or editing, printing, audible displays, alerts, etc). UCI design considerations which should be addressed using static prototypes include:

a) display layouts and arrangements
b) displayed data content (comprehensiveness, information density, accuracy)
c) dialog format selection (menu structures, commands, query formation, etc)
d) job performance aid/help screen design and content
e) display arrangement standards and consistency
f) information coding (use of colors, symbols, and other static codes)
g) terms, abbreviations, acronyms and labels
h) error and prompt message design.

4.2.3.2 Use of dynamic rapid prototypes.

Dynamic prototypes should be used for evaluation of UCI interface which are stable in display presentation, and for evaluation of the dynamic characteristics which are simulated by the prototype. In general, dynamic prototypes should simulate operations such as paging through

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displays, navigating though menu hierarchies, limited data entry and access, and requesting and receiving system help. Dynamic prototypes should not be used (unless specifically accommodated by the prototype) to evaluate time dependent operations, transitional transactions, or data exchange/handling operations. UCI design considerations which should be addressed using dynamic prototypes include, in addition the the considerations of static prototypes:

a) menu hierarchic design, structure and organization
b) data entry and simple data access (display paging, scrolling)
c) command structure (tradeoffs of iconic/command/key functions, etc)
d) help access
e) command sequences, display sequences
f) display formats and consistency.

4.2.3.5 Use of robust prototypes.

Robust prototypes should be used for evaluation of the dynamic characteristic of UCI interfaces. Robust prototypes should simulate most, if not all, user-computer interactions. Where possible, robust prototypes should incorporate the underlying applications code which will manipulate data in the final system, or should simulate actual data handling. The timing and pacing characteristics of the robust prototype should closely approximate that of the final system. UCI design considerations which should be addressed using robust prototypes include:

a) control operations (menus, commands, function keys, queries, merging commands, etc.)
b) data entry, editing and access
c) system prompting, cueing, structuring
d) error detection, errors messages and user responses
e) graphics, data manipulation
f) display dynamics (symbol movement such as velocity vectors, text updates other than that of the user, cursor flashing, etc)
g) data field entry (cursor movement, tabbing, etc)
h) dynamic coding (flash rates, intensity, auditory signals, colors, speech, etc)
i) device inputs/outputs
j) panning, paging, zooming, scrolling, searching, etc.

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4.3 General HFE principles of UCI design. User-computer interfaces should be designed in conformance with the following nine general human factors engineering principles of user-computer interface design:

4.3.1 Acceptable workload - Workload should be within the capability limits of the user, and where possible, the user should direct system operation and control the pace of transacting with the system.

4.3.2 Assurability - The system should help assure data quality and transaction control by supporting the user in validating data, avoiding input errors, notifying the user of detected errors, and offering guidance in correcting errors.

4.3.3 Brevity- User input and computer output should be brief and concise and should reduce long and short term memory loads imposed on the user, and where possible, recognition rather than recall should be required of the user.

4.3.4 Compatibility - User input should be compatible with computer output, and computer output should be compatible with human expectations, information assimilation capabilities, and information processing capabilities.

4.3.5 Consistency - The system should provide a consistent interface environment and perform in a consistent, reliable, and predictable fashion.

4.3.6 Definition of role - The user should know what functions the user will perform and what functions the system will perform within dialogs.

4.3.7 Flexibility/adaptability - User input and computer output should depend on user experience, capability, expectation, and individual style, and should accommodate individual differences in style and abilities.

4.3.8 Feedback - Immediate feedback should be provided the user concerning system status and user performance.

4.3.9 Simplicity - User input and computer output should be formed into short, readily understandable structures.

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5 Detailed guidelines.

5.1 Dialog/interactive control.

5.1.1 General.

a) The user should have the initiative in transaction control, and system control should be subordinate to user control. Users should provide the pace of transaction sequences.

b) Transaction control should be by explicit user action.

c) Control by simultaneous users should not interfere with those of other users.

d) Transaction options should be provided which match expected user goals and tasks. For example, if users must frequently sort data by selected data elements within a form, a simple to implement SORT BY command should be provided.

5.1.1.1 Log-on.

a) When users must log-on to a system, log-on should be a separate procedure that is completed before a user may select any operational options.

b) The log-on frame should appear as soon as possible on the display with no additional user involvement and should include prompts for the log-on procedure.

c) Log-on delays should be accompanied by an advisory message to tell the user status and when the system will become available. See figure 4.

```
** Notice **
---------------
System unavailable until
1400 hours
```

FIGURE 4. Example log-on frame notice.

d) Knowledge of the internal mechanisms and other technical aspects of the system should not be required of the user to log-on or otherwise use the system.

e) Average system response time, if affected by the number of on-line users, should be displayed at time of log-on. This message should not be in code but should contain specific information concerning current response time and the periods when response time is relatively quick. Examples of system response time messages are contained in figure 5.

f) After completing the log-on process, the user should be able to start productive work immediately.

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Dialog/interactive control - General

Poor	Better
System load 4	Current maximum response to simple commands is now running at 10 to 15 seconds.
System load medium	System response time is usually 1 to 2 seconds between 1100 and 1200 and after 1600 hours.

FIGURE 5. Examples of log-on response time messages.

5.1.1.2 Log-off.

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

b) Interactive timesharing systems should allow time (e.g., 5 to 15 minutes), between keyboard actions before automatic log-off, unless a longer period is requested by the user.

c) An audible signal should be presented at specified intervals prior to automatic log-off.

d) Where possible, open files should be saved to some defined file name. An example of an automatic file save dialog is presented in figure 6.

e) A message should be presented on screen prior to the automatic log-off instructing the user how to avoid automatic log-off.

** NOTICE **

Session log-off due to user inactivity.

File saved to user account as:

Malone.ScratchFile.6:6:88"

FIGURE 6. Automatic file closure and saving operation at time of log-off.

5.1.1.3 Simplicity.

a) Transaction control should be simple, flexible, adaptive, consistent, minimize user actions, compatible with the lowest anticipated user skill level, and should be logical in terms of user task sequences and functions.

b) Users should be able to predict system responses to their actions.

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c) Transaction control should be consistent in form and consequences and employ similar means to accomplish similar ends.

d) When hierarchical levels are used to control a process or sequence, the number of levels should be minimized.

e) Display and input formats should be similar within levels and the system should indicate current positions within a sequence.

5.1.1.4 Transaction selection.

5.1.1.4.1 Timing and pacing. Users should be able to select transactions; computer processing constraints should not dictate transaction control. When appropriate to task requirements, users should be able to specify transaction timing; i.e., when a requested transaction should start or be completed, or the periodic scheduling of repeated transactions. See figure 7.

Set automatic Transmission for every

5

Minutes?
<ENTER> to accept default, or,
input new value then <ENTER> to change.

FIGURE 7. User specification of optimal transaction timing.

5.1.1.4.2 Options list/prompting.

a) A general list of basic control options should be available to serve as a "home base" or consistent starting point for control entries.

b) A general options list should present options grouped, labeled and ordered in terms of their logical function, sequence, frequency, and criticality of use.

c) A list of the control options that are specifically appropriate for any transaction should be displayed by listing in the working display or by user command.

d) Information that the user needs to perform transactions should be displayed without burdening short and long term memory.

e) Transactions should never leave the user without further available action and should provide next steps or alternatives, for example, "Continue", "Abort", "Go to Main directory", etc.

f) Control entry prompting (e.g., HELP functions) should be provided.

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5.1.1.4.3 Command selection.

a) Task oriented wording for control options should be used to reflect the users view of the current transaction; for example, when assigning aircraft to a mission, the relevant control option should be ASSIGN rather than ENTER.

b) Only available transaction options should be offered to users and control defaults should be indicated.

c) A consistent control option to continue to the next transaction should be provided; e.g., if data entry is involved, then user should be required to take an explicit ENTER action to signal data entry, rather than simply selecting CONTINUE, ENTER, TAB or NEXT.

d) User interrupt or abort functions to terminate transactions should be provided.

e) The requirement to learn mnemonics, codes, special or long sequences, and special instructions should be minimized. See example in figure 8.

POOR	BETTER
ATTN;,,@PRINT	PRINTER 1/PRINT

FIGURE 8. Examples of poor and better command selection.

5.1.1.4.4 Merging commands.

a) Users should be able to key a sequence of commands or option codes as a single control entry, and should be able to assign a name and use that named "macro" for subsequent command entry.

b) For control entry merging, command names, abbreviations, or option codes should be accepted as if those control entries had been made separately.

c) Required punctuation of merged entries should be minimized. A standard delimiter in separating commands should be used; e.g., a slash (/). See figure 9.

```
List Command String:  SORT/SAVE/TRANSMIT
Identify command key sequence
(ALT or CONTROL + <character>):  ALT P
Replace  old "ALT P" ("SORT/SAVE')
With "SORT/SAVE/TRANSMIT" (Y or N):
```

FIGURE 9. Possible dialog to establish 'macro' command.

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5.1.1.5 Context definition.

a) Transaction context should be provided for the user.

b) Unless contextual interpretation of commands would have destructive effects (e.g., data deletion), transaction control software should interpret current control actions in the context of previous entries without requiring users to reenter data; for example, requiring users to specify a text name during repeated text entry/editing and related operations. Examples of context definition are presented in figure 10.

Poor	Better
SAVE 'OCSOT REPORT REV. 3' <data entry> SAVE 'OCSOT REPORT REV. 3' <data entry> SAVE 'OCSOT REPORT REV. 3' TRANSMIT 'OCSOT REPORT REV. 3'	SAVE 'OCSOT REPORT REV. 3' <data entry> SAVE <data entry> SAVE TRANSMIT

FIGURE 10. Examples of transaction context definition.

c) Users should be able to request a summary of the results of prior transactions to determine present status; for example, waiting in a print queue.

d) When context for transaction control is established in terms of a defined operational mode, the operational mode should be displayed.

e) Users should be able to review control parameters that are currently operative.

f) If the consequences of a control entry will differ depending upon context established by a prior action, a continuous indication of current context should be displayed.

g) When performing an operation on a selected item, the item should be highlighted.

h) Information displayed to provide context for transaction control should be distinctive in location and format, and consistently displayed from one transaction to the next.

i) Displayed options, command entry areas, prompts, advisory messages, and other displayed items (titles, time signals, etc.) relevant to transaction control should be distinctive in position and format.

j) Formats should be consistent from one frame to the next.

Dialog/interactive control - General

5.1.1.6 Abbreviations and acronyms.

a) Where possible, use of abbreviations and acronyms should be avoided. Where not

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possible, standard abbreviations, acronyms, and display codes should conform to MIL-STD-12, MIL-STD-411, OR MIL-STD-783.

b) New acronyms, if required, should be developed according to the rules of MIL-STD-12. Extent of deviation from abbreviation rules should be minimized.

c) Abbreviations, mnemonics, and acronyms should not include punctuation.

d) When abbreviations are used, a dictionary of abbreviations should be provided to the user.

e) Abbreviations should be unique, distinct and unambiguous, and using them should not confuse the user or add to system operation time.

5.1.1.7 Labeling and terminology.

a) Consistent terminology for transaction control should be adopted.

b) Congruent names for control functions should be adopted; e.g., SAVE - DELETE vs. FILE - DESTROY.

c) Transaction wording should be consistent with user guidance and frame of reference.

d) For interpreting user-composed control entries, upper and lower case letters should be treated as equivalent.

e) The length of individual input words (commands, keywords) should not exceed seven characters.

5.1.1.8 Prompting/structuring.

a) The system should contain prompting and structuring features designed to: prompt for all required input parameters; request additional or corrected information from the user; provide orientation to the user during transactions; and indicate when errors have been detected.

b) Prompts should inform the user what information is to be input.

c) Where six or fewer control options exist, they should be listed. Where more input options exist, an example of the type of entry that is required should be presented.

d) The system should prompt for all required input parameters. The level of prompting detail should be controllable by the user.

Dialog/interactive control - General

e) Prompting messages should appear at a standard location on the screen; e.g., at the beginning of the next line to be typed, in the data field where an entry is to be made, at a command input line, or within a menu window from which a selection will be made.

5.1.1.9 System messages.

a) Message language should be distinct, meaningful, and easily discriminated.

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b) Humorous or sarcastic messages should be avoided.

c) Messages should make the user feel in control.

d) Messages should not present the system as a person. See figure 11.

POOR	BETTER
I AM LOADING THE FILE YOU REQUESTED... I'LL BE DONE IN A BIT	LOADING FILE 'TEST DATA' PLEASE WAIT . . .

FIGURE 11. Examples of poor and better system messages.

e) When a message appears on the screen, both the content of the message and the action required by the user should be explicit.

f) Messages detailing the users status (such as accounting information, files in use, etc.) should be displayed.

5.1.1.10 Feedback.

a) Positive feedback should be provided for all control entries.

b) Completion of transaction processing should be indicated by feed back messages.

c) When system functioning requires the user to standby, periodic feedback should be provided to indicate normal system operation.

d) Successive periodic feedback messages should differ in wording from presentation to presentation, or be otherwise indicated. An example of periodic feedback messages is presented in figure 12.

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Dialog/interactive control - General

Successive periodic feedback messages	1st →	Processing search - Please wait
	2nd →	Search continuing - Please wait
	3rd →	Processing search - Wait please
	final →	** Search Complete **

FIGURE 12. Example of periodic feedback message.

5.1.1.11 Alarms.

a) Where alarm conditions are not predefined by functional, procedural, or legal requirements, users should be able to define the conditions (in terms of variables and values) that will result in computer generation of alarm messages.

b) Alarms should be distinctive and consistent.

c) Users should be provided with a simple means of acknowledging and turning off noncritical alarm signals without erasing any displayed message that accompanies the signal.

d) If users are required to acknowledge a special or critical alarm in some special way, acknowledgment should not inhibit or slow user response to the alarmed condition.

5.1.1.12 System response time.

a) Computer response time to user entries should be appropriate to time constraints imposed by the task or mission, specific data processing applications, and type of transaction.

b) The guidelines of Table 3 should be used as guidance for maximally acceptable system response time.

c) Temporary keyboard/device lockout due to processing of transaction control entries should be minimized, and should not exceed 0.2 seconds.

d) Where control entries must be delayed pending computer processing of prior entries, then control entry should be acknowledged.

e) When display generation is slow, the user should be notified when the display output is complete.

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TABLE 3. Acceptable system response times for routine system tasks.

System Interpretation	Response Time Definition	Acceptable Response Time (Seconds)
Key Response	From key depression until positive response; e.g., "click" or display echo	0.1
Key Print (echo)	From key depression until appearance of character	0.2
Page Turn	From end of request until first few lines are visible	1.0
Page Scan	From end of request until text begins to scroll	0.5
Data Field Entry	From selection of field until visual verification	0.2
Function Selection	From selection of command until response	2.0
Pointing	From input of point to display of point or pointing device	0.2
Drawing/ Sketching	From input of point to display of point, line, arc, etc.	0.2
Local Update	Change to image/display using local data base, e.g., new menu list display	0.5
Host Update	Change where data is at host in a readily accessible form, e.g., a display scale change	2.0
File Update	Image/display update requiring access to a host file	10.0
Simple Inquiry	From command until display of a common message	2.0
Complex Inquiry	Response message which requires seldom used calculations in graphic form	10.0
Error Feedback	From entry of input until error message appears	2.0

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Dialog/interactive control - General

f) Control response time variability should be within the limits of figure 13.

Control Response Time		Variability
0 to 2 seconds	-	less than 5%
2 to 5 seconds	-	less than10%
greater than 5 seconds	-	less than15%

FIGURE 13. Maximum control response time variability.

5.1.1.13 Dialog type selection.

a) Dialog type should match task requirements and user abilities. The guidance below and in figure 14 should be used to make dialog type selection decisions.

b) Question and answer dialog may be used for routine data entry tasks, where data is known and ordering can be constrained, for users with little or no training, and where computer response is expected to be moderately fast.

c) Form filling dialog may be used where flexibility in data entry is needed, where users are moderately trained, where computer response may be slow, and as an aid for composing complex control entries.

d) Menu selection dialog may be used for tasks that involve choice among a constrained set of alternatives, where little entry of arbitrary data is required, where users have little training, when a command set is too large to commit to user memory, and where computer response is relatively fast.

e) Function keys may be used in conjunction with other dialog types for tasks requiring a limited number of control entries, as an immediate means to accomplish frequent or control transactions, or for criteria control entries e.g., "help", "cancel", etc.).

f) Command language dialog may be used for tasks involving a wide range of control entries, where users are highly trained or will use the system frequently, and for tasks where control entries may be mixed with data entries in arbitrary sequence.

g) Query language dialog may be used for tasks emphasizing unpredictable information retrieval (as in many analysis and planning tasks) with moderately trained users.

h) Constrained natural language dialog may be used in applications where task requirements are broad ranging or poorly defined, and where little user training can be provided.

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Dialog/Interactive Control - Dialog type selection

Question and answer	Form Filling	Menu Selection	Function Keys	Command Language	Query Language	Constrained Natural Language	
				•			Arbitrary control/data entry sequences
						•	Poorly defined/broad interface definition
					•	•	Unpredictable information retrieval
				•			Wide range of control entries
			•				Frequent control/transactions
		•	•				Small/constrained command choice set
	•						Complex control
		•					Large command set
•							Routine data entry
•							Entry order constrained
	•						Data entry flexibility needed
		•					Little arbitrary data input
	•						Slow computer response time
•		•					Fast computer response time
				•			Highly trained users
	•				•		Moderately trained users
•		•				•	Little training

FIGURE 14. Dialog type selection.

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Dialog/Interactive Control - Question and Answer Dialog

5.1.2 Question and answer dialog.

a) Questions should be displayed separately, posing of compound questions should be avoided.

b) When computer posed questions are interrelated, answers to previous questions should be displayed; users should not be required to remember prior answers to provide context for current questions. An example of a question and answer dialog which provides context is presented in figure 15.

Lock on target '14'?: Y

Illuminate target?: Y

Continuous track update?: Y

Initiate engagement sequence?: ▮

Y-Yes	N-No	D-Drop Track	N-New	E-Exit

FIGURE 15. Example question and answer dialog providing context.

c) As appropriate, question sequence should be compatible with source documents.

5.1.3 Form filling dialog. In addition to the guidelines contained here, the guidelines of section 5.2, "Data Entry", and Section 5.2.4, "Form Entry", should be applied to the design of form filling dialogs.

a) As appropriate, defaults for control entry in form filling should be provided.

b) Control forms and formats should be presented in a consistent and logical format.

5.1.4 Menu selection dialog.

a) Each related group of menu options should permit only one selection by the user. Where multiple options can be selected, they should be identified, by label (e. g., "Check Selections Desired") or by option coding.

b) All available options should be explicitly and completely displayed for a selected menu.

c) Users should be able to distinguish between available and unavailable options.

d) Unavailable menu options should be displayed along with available options.

Dialog/interactive control - Menu selection dialog

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e) An input prompt should clearly indicate to the user that the computer is waiting for a response and a standard symbol should be used for prompting entry.

f) Feedback for menu selection should be provided.

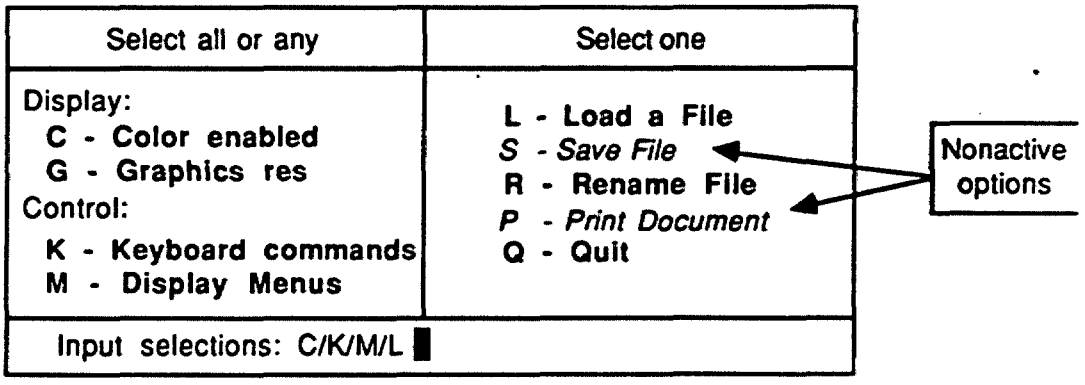

FIGURE 16. Example of a menu selection screen.

5.1.4.1 Format.

a) Logically related options within a list should be grouped, and groups should be segregated by lines or other means.

b) Unless constrained by available display space, related menu options (PRINT commands, FILE commands, etc.) should be formatted as a single column list.

c) Menu options should be logically ordered and grouped, by frequency of use, importance, functional relations, or sequence of use.

d) Where ordering cannot be determined by frequency of use, importance, functional relations, or sequence, alphabetic ordering should be used.

e) Menus provided in different displays or contexts should be designed so that option lists are consistent in wording and ordering.

f) Pop-up, pull-down, and windowed menus should be displayed in consistent screen locations for all modes, transactions, and sequences.

g) Menus should be distinct from other displayed information.

5.1.4.2 Labeling and terminology.

a) An explanatory title for each menu should be provided. Where menu options are grouped in logical subunits, each group should be provided a descriptive label that is distinctive in format from the option labels themselves.

Dialog/interactive control - Menu selection dialog

b) Menu options should be worded as commands rather than as questions to the user.

c) When menu selection is used in conjunction with command language, menu option wording

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should be consistent with command language.

5.1.4.3 Menu option selection.

5.1.4.3.1 Pointing and selecting.

a) Menu selection from displayed options should be implemented by direct pointing (touch display, lightpen, etc.), or indirect pointing (mouse, trackball, etc.) devices.

b) Where direct pointing devices are used in menu selection, a sufficient pointing area should be provided to preclude selection errors. See figures 17.

c) Where indirect pointing devices are used in menu selection, a large pointing area for option selection should be provided, including the area of the displayed option label, plus a half-character distance around the label. See figure 18.

d) When menu selection pointing is via cursor control keys or tabbing, the cursor should automatically be placed at the first listed option.

e) Experienced users should be able to bypass a series of menu selections and make an equivalent command entry directly, without using pointing or cursor control devices.

f) When equivalent keyboard commands are provided as means of menu selection, they should be displayed as part of the menu option label. See figure 19.

5.1.4.3.2 Key coded menu selection.

a) Menu selection by keyed entry may be used when menu selection is a secondary or occasional means of control entry, or where short option lists are needed.

b) Options should be coded by the first letter or several letters of their displayed labels, rather than by arbitrary numeric codes.

c) When menu items are coded, a standard display area for code entry should be provided, and the cursor should be placed in the command entry area.

d) Codes associated with each option should be displayed in a consistent, distinctive manner.

e) One (1) letter codes for menu selection, rather than assigning arbitrary letter or number codes, should be provided. See figure 20.

f) Coding of menu options should be consistent among display screens and system use contexts.

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Dialog/interactive control - Menu selection dialog

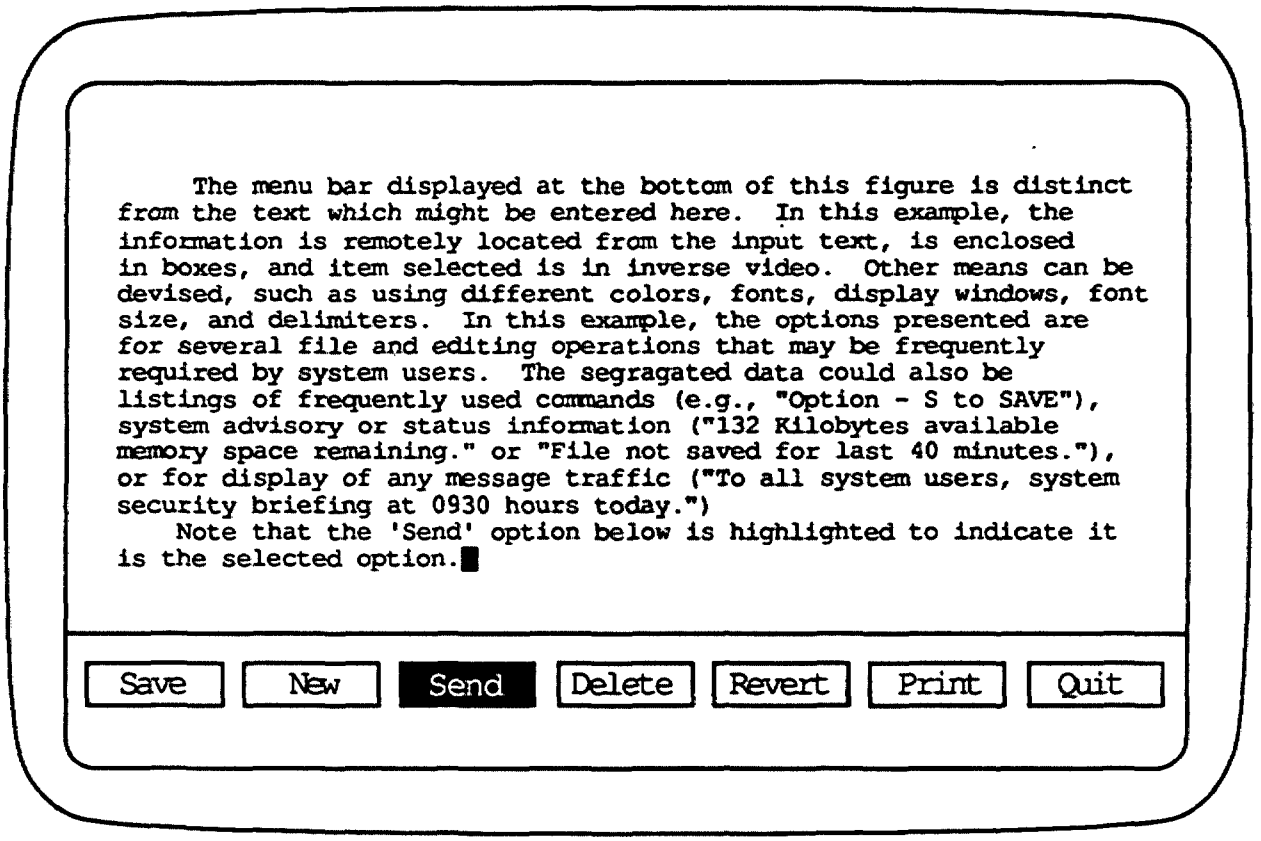

FIGURE 17. Example of menu selection by pointing or tabbing.

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Dialog/interactive control - Menu selection dialog

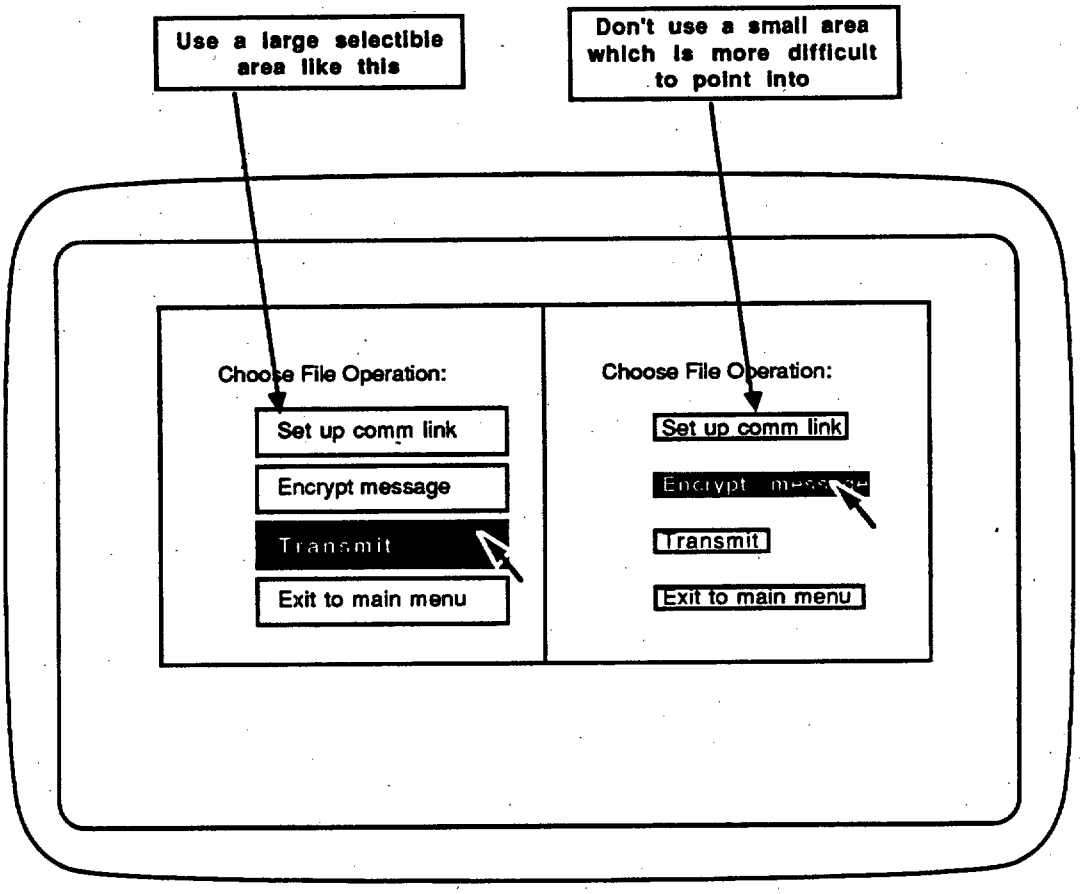

FIGURE 18. Example of menu selection by indirect pointing.

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Dialog/interactive control - Menu selection dialog

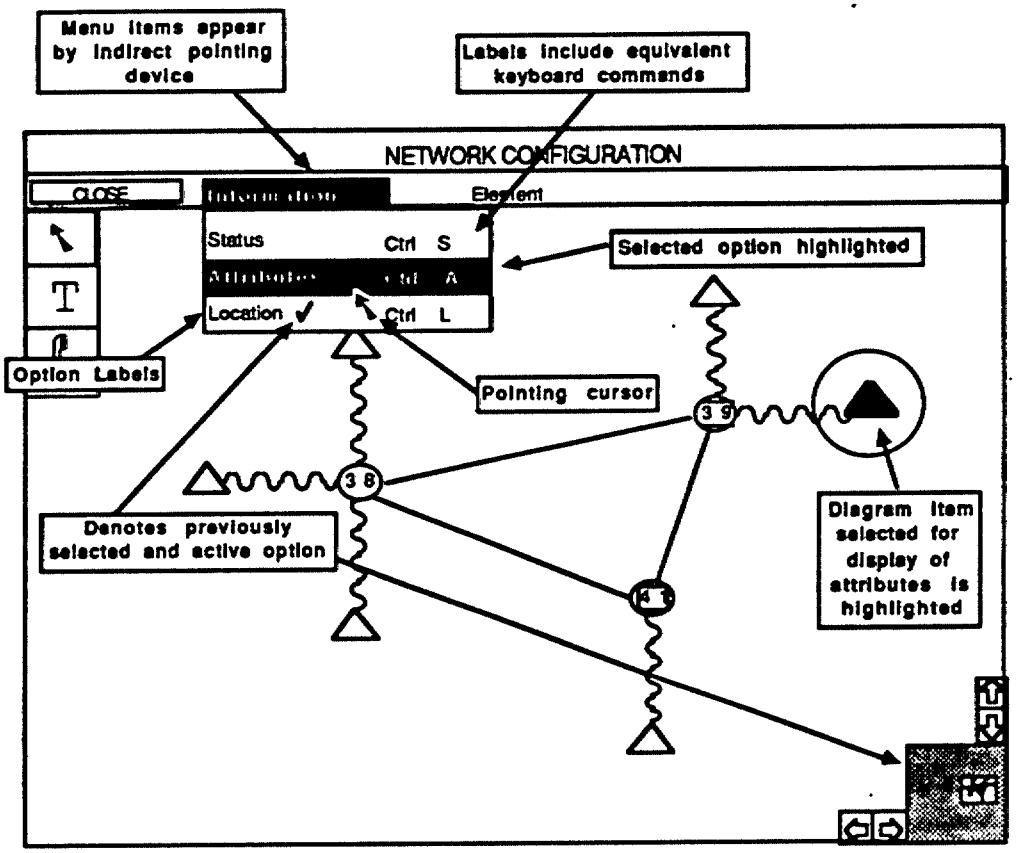

FIGURE 19. Example of pull-down menu which displays keyboard equivalent commands.

POOR	BETTER
1 - Identify Friend or Foe 2 - Lock on target 3 - Assign 4 - Engage 5 - Assess Kill	I - Identify Friend or Foe L - Lock on target A - Assign E - Engage K - Kill assessment

FIGURE 20. Example of key coded menu items.

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5.1.4.4 Hierarchic menu design.

a) When menu selection must be made from a long list, hierarchic menus for sequential selection should be provided, but the number of hierarchic levels should be minimized.

b) Each menu option list should have 4 to 8 options, menus with less than 3 options should be avoided.

c) A general menu of basic options, as the top level menu, should be provided which is as unambiguous as possible.

d) Menu elements subordinate to top level menus should be logically related; e.g., FILE transactions, PRINT transactions, EDIT,etc.

e) Hierarchic menus should be structured to permit immediate user access to critical or frequently selected options and should minimize the number of steps required.

f) Users should have to make only one control action to move to the next higher level, and a separate simple control action to return to the general menu at the top level.

g) Design and use of hierarchic menus should be consistent across task and transaction contexts.

h) The current position within menu structures should be indicated when hierarchic menus are used.

i) Hierarchic menu control options should be distinct from menu branching options.

5.1.5 Command language dialog.

a) Once a command has been composed, an explicit enter or execute should be provided.

b) Standard techniques for editing commands should be provided.

c) If a command entry is not recognized, user should be able to revise/replace the command.

d) If a command entry may cause delays, delete or modify data, or have other potentially adverse consequences, the user should be required to review and confirm a displayed interpretation of the command before it is executed.

5.1.5.1 Labeling and terminology.

a) Command language should be designated so that a user can enter commands in terms of functions desired.

b) Command names and language should be meaningful, use familiar wording, and be distinctly and consistently worded.

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c) Codes should be designed to aid memory.

d) If a system will have many novice or infrequent users, the system should recognize a variety of synonyms or alternative syntax for each word defined in the command language.

e) Where possible, commands should be selected such that common misspelling errors do not represent valid commands (e.g., DEL for Delete and SEL for Select, would be a common error since the characters 'd' and 's' are adjacent on QWERTY keyboards).

f) Words and abbreviations in a command language should be distinctive. For example, 'FILL' (a graphic command) and 'FILE' (a file operation command) are too similar, use of 'PAINT' and 'FILE', or 'FILL' and 'SAVE' would be preferred.

g) Commands should not consist only of non-alphanumeric characters (e.g., "$." as a command to stop printing. If "$" were a system attention symbol, then "$S" would be a better command to stop printing).

5.1.5.2 Format, syntax and layout.

a) A standard display area for command entry should be provided. When possible, command entry should be located at the bottom of the screen.

b) Command language functions should be organized in groups for ease of learning and use.

c) For infrequent or untrained users, syntactic complexity should be minimized.

d) Command language syntax should be consistent across different transactions. For example, use of special symbols such as quotation marks, key use (OPTION, COMMAND, ETC.), and sequence. See figure 21.

POOR	BETTER
SAVE AS WEAPON FILE <ENTER>	SAVE AS WEAPON FILE <ENTER>
WEAPON FILE DELETE <RETURN>	DELETE WEAPON FILE <ENTER>
WEAPON FILE RENAME WEP 1 <ENTER>	RENAME WEAPON FILE/WEP 1 <ENTER>

FIGURE 21. Examples of poor and better command consistency.

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Dialog/interactive control - Command language dialog

5.1.5.3 Keying requirements.

a) Required use punctuation should be minimized; where required, a standard delimiter (such as a /) should be used.

b) Blanks in command entry should be ignored by the system.

c) Users should be able to use abbreviated forms of any command of more than 5 characters.

5.1.5.4 Job performance aids.

a) Users should be able to request guidance information necessary to determine required parameters or options in a command entry, or to determine available options for a command.

b) Where possible, guidance information should be accompanied with graphic examples of command content and syntax.

c) A general list of basic commands, with appropriate command format, should be provided.

5.1.6 Query and natural language dialogs.

5.1.6.1 Terminology.

a) The wording of a query should specify what data are requested, not how to find the data.

b) A query language should be designed so that it reflects a natural data structure or organization.

c) Users should be able to employ alternative forms when composing queries, for example:

"Updata target display within 3 miles"
"Updata target display in a three mile radius"
"Updata target display out three miles."

d) Where possible, need for quantifiers ("less", "without", "excluding") in specifying queries should be minimized.

5.1.6.2 Limiting and combining queries.

a) When a query may result in a large-scale data retrieval, the user should be required to confirm the transaction or take further action to narrow the query before processing.

b) Query language should include logic elements that permit users to link sequential queries as a single entry, such as "and", "or", etc.

c) A query language should be capable of linking sequential queries by use of statements such as, "of those records retrieved..." or "how many of the remaining candidates..."

Dialog/interactive control - Function keys

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5.1.7 Function keys.

5.1.7.1 Labeling and identifying.

a) Function keys should be distinctively labeled.

b) If key function is variable, current active function should be appropriately labeled by adjacent screen location or other means.

c) Function keys status (e.g., active - inactive) should be indicated. Unneeded or disabled function keys should be disabled and so indicated by the system. See figure 22, below.

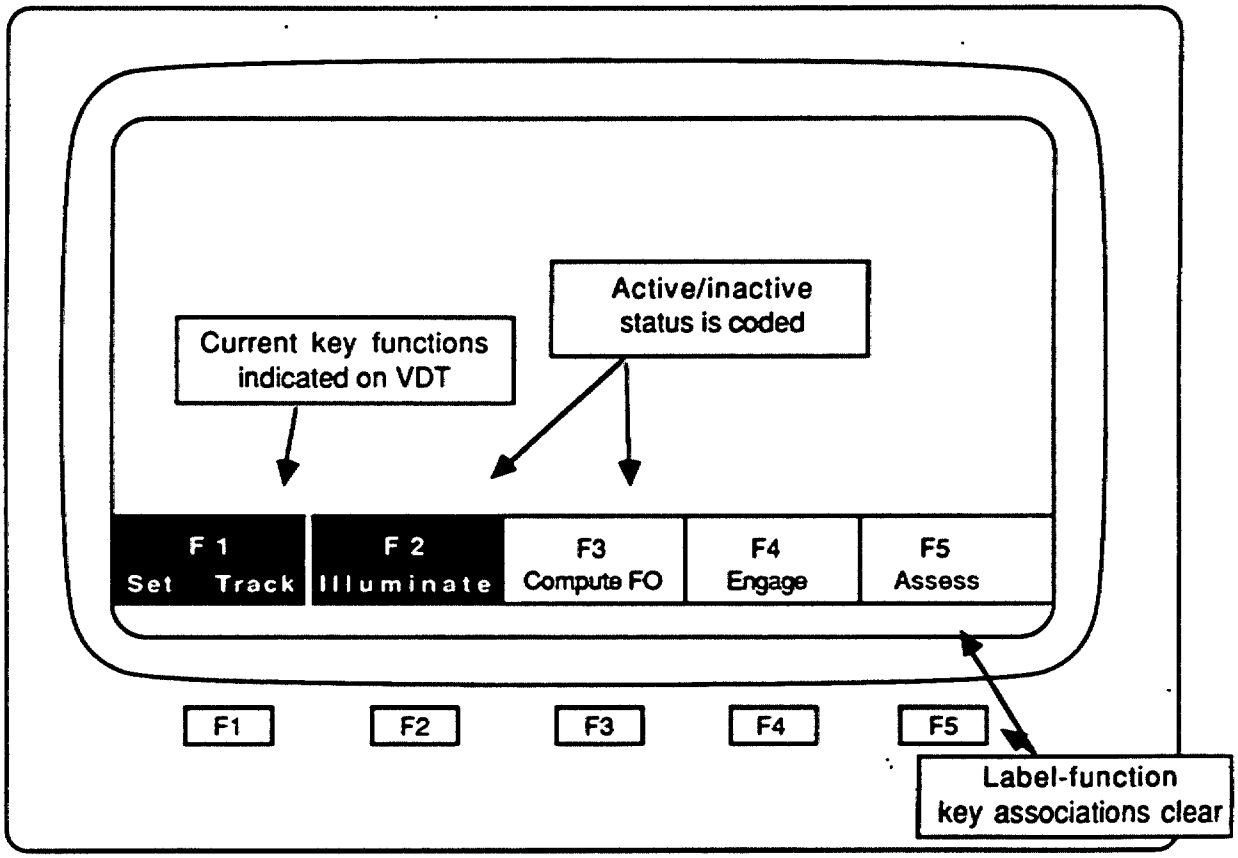

FIGURE 22. Example of variable function key use, identification and coding.

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Dialog/interactive control - Function keys

5.1.7.2 Single and double keying.

a) Keys controlling frequently used, critical, or time constrained functions should permit single key action and should not require double keying (e.g., <Control>- F1, or , <Option> - SAVE).

b) Double-keyed functions should be logically paired and consistently logical.

c) Keys should perform labeled functions with a single activation, and should not change its function with repeated (e.g., double stroke) activation.

5.1.7.3 Feedback.

a) Feedback should be provided for function key activation, particularly when activation does not result in any immediate observable response.

b) When system functioning requires the user to standby, periodic feedback should be provided to indicate normal system operation.

5.1.7.4 Format and layout.

a) Function keys should be grouped in distinctive locations on the keyboard.

b) Frequently used, important, or critical function keys should be placed in the most convenient locations.

c) The layout of function keys should be compatible with their importance.

d) Physical protection should be provided for keys with potentially disruptive consequences, such as CLEAR MEMORY.

5.1.7.5 Modes/function.

a) When a function is continuously available, the function should be assigned to a single key.

b) Key functions in different operational modes should be consistent or similar. For example, when a key (e.g., "F1") confirms data changes in one mode, it may confirm message transmission in another (the confirmation function is the same).

c) When the functions assigned to a set of keys change as a result of user selection, the user should be provided an easy means to return to the base-level functions.

d) Where possible, experienced users should be able to define their own key functions (for example, a repetitive transaction sequence such as FIND - [field value]- REPLACE [field value] - WITH [field value] - SAVE RECORD, may be assigned temporarily to a function key).

Dialog/interactive control - Iconic interaction

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5.1.8 Iconic interaction.

a) Icons may be used to graphically represent operations, processes and data structures, and may be used as means of exercising control (e.g., by selecting an icon and commanding operations such as DELETE, COPY, PRINT) over system functions, components, and data structures.

b) Iconic representations should not be used when display resolution is low.

c) If icons are used to represent control actions in menus, a label should be associated with each icon.

d) Icons should be consistent and predictable across operating modes and across applications.

e) Icons should be graphically designed to the processes or operations they represent, by use of literal (e.g., a figure of an aircraft), functional (e.g., a figure representing a network), or operational (e.g., pen in hand on paper) representations.

f) Abstract or humorous representations should be avoided. Examples of of literal, functional, and operational icons are presented in figure 23.

g) Icon manipulation should occur as recommended in section 5.2.6 "Graphics Entry" of this document.

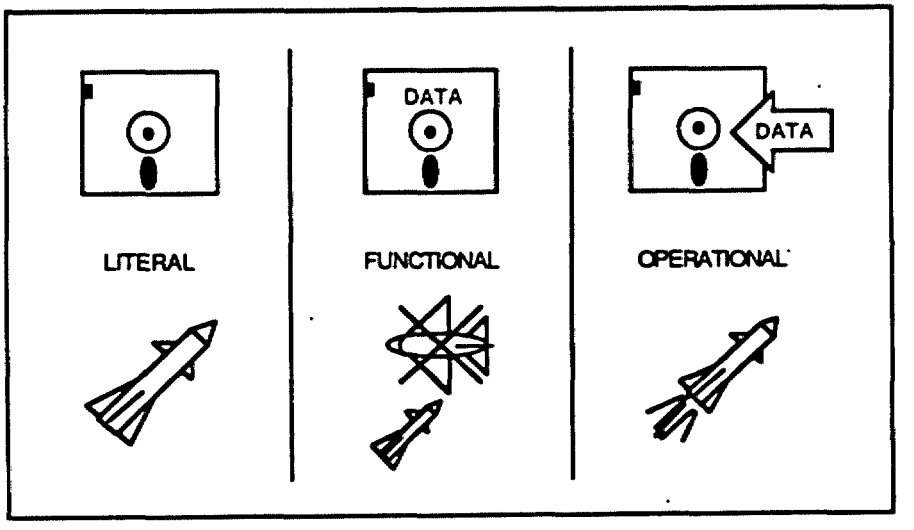

FIGURE 23. Examples of icons.

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Dialog/interactive control - User transaction interrupts

5.1.9 User transaction interrupts.

a) Means to interrupt or cancel transactions should be provided, should be distinctive (e.g., PAUSE and STOP may be confused, as well as STOP and END), and should occur only by explicit user action.

b) User interrupts and aborts should not modify or remove stored or entered data.

c) As appropriate to specific transactions, the following interrupts should be provided:

1. CANCEL (or UNDO) should erase any immediate changes (e.g., a drawn line, or typed text string) and restore the display to its previous version.

2. BACKUP should return the display to the last previous transaction.

3. REVIEW should return to the first display in a defined transaction sequence, permitting the user to review a sequence of entries and make necessary changes. REVIEW should be nondestructive.

4. RESTART or REVERT should cancel any entries made in a defined transaction sequence and return to the state at the beginning of the sequence (e.g., reload a file, clear all entered data since file load, etc). When data entries or changes will be nullified RESTART action, users should be required to CONFIRM the RESTART.

5. END (or EXIT) should conclude a repetitive transaction sequence.

6. PAUSE and CONTINUE should temporarily interrupt a transaction sequence without change to data or control logic. When PAUSE is selected, a PAUSE status indication should be presented.

7. SUSPEND should preserve (save) current transaction status when a user leaves the system, and resume at that point when the user again logs on the system. When SUSPEND is selected, an indication of the SUSPEND status should be presented.

5.1.10 Error management.

a) Users should be able to edit a command during its composition before making an explicit ENTER action, and should be able to stop a control process at any point in a sequence to correct an error.

b) Interface software should deal appropriately with all possible control entries, correct and incorrect.

c) System and software should be able to distinguish between program errors, equipment failures, and operator errors and, where failures result in shutdown, allow for minimum loss of work performed.

Dialog/interactive control - Error management

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5.1.10.1 Error detection.

a) If only a portion of a merged command, or an entered string of commands, can be executed, the user should be alerted and guidance provided to permit correction, completion, or cancellation of the merged command.

```
** ERROR **

Unable to execute command string:

LOAD/FIND 'FOXBAT.DATA'/PRINT

ERROR --> File not found

F1 - REDO FROM START   F2 - EDIT COMMAND STRING   F3 - CANCEL
```

FIGURE 24. Example of error message.

b) When an error is detected in a string of command entries, the system should either consistently execute to the point of error, or consistently require users to correct errors before execution.

c) If a menu selection, function key, command, etc. entered is invalid or inoperative at the time of selection (e.g., attempting to print a document from within an edit mode), no action should result except a display of an advisory message indicating what functions, options, or commands are appropriate.

d) When appropriate, the display should provide troubleshooting alternatives to aid in locating the problem which caused the error.

5.1.10.2 Error messages.

a) Error messages should indicate why control input was rejected and what corrective actions may be taken. Where possible, error messages should distinguish between syntax errors (such as use of a wrong delimiter) and keying errors (such as misspelling a command).

b) Error messages and guidance that will not fit on the display should contain references to on-line documentation which will provide further guidance, users should not have to refer to secondary written procedural references.

c) Error messages should be displayed with the rejected input and the portion of the input in error should be highlighted. An example of a highlighted portion of an error message is presented in figure 25.

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Dialog/interactive control - Error management

```
** ERROR **

Unable to interpret command string:

LOAD 'Air.Data'/FIND 'FOXBAT.DATA'/RINT

ERROR --> Command name not recognized

F1 - REDO FROM START    F2 - EDIT COMMAND STRING    F3 - CANCEL
```

FIGURE 25. Error message which highlights uninterpreted command segment.

5.1.10.3 Error correction and recovery.

a) When a command entry is in error, is not recognized or is not appropriate, users should be able to correct, without reentering, the command.

b) Entry of corrections should require an explicit action, and should require the same ENTER action for reentry that was used for the original entry.

c) Easy means to return to the main dialog after error correction should be provided.

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5.2 Data entry.

5.2.1 General.

5.2.1.1 System response time and user pacing.

a) The system should acknowledge user inputs rapidly, preferably within 0.2 seconds after data entry.

b) Users should be able to pace data entry, without limitations controlled by computer processing or external events.

5.2.1.2 Editing during entry.

a) Users should be able to perform simple editing during data entry, without entering special editing modes (for example, by use of destructive backspace to erase and retype characters to the immediate left of the cursor).

b) Users should be able to change entries by consistent means; e.g., exclusive use of typeover or DELETE/INSERT.

c) Users should be able to enter data via a consistent mode (keyboard, lightpen, mouse, etc), without having to change modes.

d) When inserting words or phrases, items to be inserted should be displayed as the final copy will appear.

e) During input data editing, the system should automatically display, or offer to display via prompt, information to be modified.

5.2.1.3 Data entry feedback.

a) Data entered should appear on the users primary display on a stroke-by-stroke basis.

b) The system should confirm completion of a data entry action by display of confirmation message or other means to indicate successful data entry.

c) Error messages should be displayed to indicate unsuccessful data entry.

d) Feedback should be provided for repetitive data entries (e.g., duplication field entries within forms or from previous forms) by system regeneration of data entries.

e) The user should be alerted when the system cannot interpret or recognize an abbreviated data entry. Where possible, the system should question the user to resolve uncertainty.

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Data entry - General

5.2.1.4 Data entry defaults.

a) Where inputs have consistent data, the user should be able to define default values, codes or strings. The system should carry the data to subsequent forms, text strings, etc.

b) When default modes are provided, the user must be able to define, modify, remove, inhibit or enable defaults at any time.

c) Users should be capable of replacing any data entry default value with a different entry without changing the default definition for subsequent fields.

d) On initiation of a data entry, defined default values should be automatically displayed and highlighted.

e) The user should be able to press one key to confirm the default values. See figure 26.

Sweep Area (degrees):	360
Azimuth (degrees):	30
Sweep speed (CPS):	2

ENTER to Accept TAB to field to change

FIGURE 26. Example of screen display of automatic default values.

5.2.1.5 Highlighting.

a) Highlighting should should be easily recognizable and be used to attract the users attention to active fields, special conditions, or as a means to provide feedback.

b) Highlighting should not interfere with the readability of displayed information.

c) A highlighting technique similar to that used on the VDT should be provided for printed output.

d) Critical data should be highlighted and should be removed when it no longer has meaning, importance, or criticality.

e) Flashing should not be used as a means to highlight routine information. Flashing should only be used as an alerting/alarming code.

Data entry - General

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5.2.1.6 Data entry fields.

a) A clear visual identification of each field should be provided.

b) Field delineation cues should distinguish basic features of required entries, i.e., maximum acceptable length, order of entry and data type. For example, a broken underscore for required entry, dots for optional entries, and asterisks for variable length entries.

c) Active data entry fields should be indicated by highlighting or other means and should provide data entry prompts.

5.2.1.7 Explicit user actions.

a) In general, explicit user actions should be required to initiate system processing, such as saving, deleting data or files, and should not occur as a result of other system commands (e.g. renaming a file, printing a file, etc.).

b) An explicit ENTER action should be required to initiate processing of entered data; an explicit CANCEL action should be required to cancel a data entry; and an explicit DELETE action should be required prior to deleting any text or other data.

5.2.1.8 Keying.

a) Where possible, users should be able to use single keystrokes to enter data. Required multiple keying (Shift-key, Option-key, Command-key, etc) should be avoided.

b) For data entry, upper and lower case keys should be treated as equivalent.

c) When entering decimal data, the system should recognize, but not require, terminal decimal points, and should recognize, but not require, typing of leading or trailing zeroes.

d) The system should treat multiple and single spaces as equivalent. Users should not be required to count spaces.

e) Keying redundant data, data already known by the system (entering both account number and user name if one specifies the other), or data that can be computed or derived should not be required except for special conditions such as data security. A glossary should link information from a record at time of entry so that keying any of the unique elements will retrieve a whole record.

f) Coded input data (alpha or numeric) should be kept short, preferably not exceeding 5-7 characters.

g) Long input data strings should be partitioned, as in telephone numbers, into shorter groups of three to five characters, separated by blanks, hyphens, or slashes, for both entry and display.

Data entry - General

5.2.1.9 Analog data input.

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a) When analog data input is based on graphic presentation of information (such as bearing vectors on a tactical display), analog means of data entry should be provided. For example, a continuous rotary switch should be used to input bearing estimations from radar displays.

b) Where analog data is based on previously quantified data, key entry should be used in lieu of analog entry. For example, entry of verbal bearing reports ("Target bearing two two five") should be entered using numeric keysets.

5.2.1.10 Hierarchical data input. If a user must enter hierarchical data, the system should guide the specification of relations in hierarchical structures.

5.2.1.11 Recurrent/derived data input.

a) When possible, routine data that can be derived from computer records should be entered automatically. For example, do not require a user to identify a work station, current date, or time.

b) When possible, computation of derived data should be provided.

c) Recurrent field entries should be retrievable for user acceptance.

d) Where data that are logically related to other entries are accessible to the computer, the computer should retrieve and enter those redundant data items automatically (for example, when an item name specifies an identification code).

e) Cross-file updating should be provided by the system. Users should not have to perform cross-file updates (for example, separate personnel, timekeeping, payroll, and voucher files should not have to be manually cross-filed).

5.2.1.12 Speech input.

a) Speech input should be used only when more reliable methods, such as keying or pointing, cannot be used.

b) Speech input should not be used as a means of transaction control when a large constrained vocabulary may exceed memory capabilities of the user, or for highly complex or nebulous operations.

c) A limited speech input vocabulary should be used and spoken entries should be phonetically distinct.

d) Input feedback and simple error correction procedures should be provided for speech input.

e) Alternative entries for speech input should be provided, as in the use of EXIT, FINISHED, and QUIT to terminate a session.

f) Provide PAUSE and CONTINUE or RESUME option for speech input.

g) Where word boundaries (pauses between words) are required for system interpretation, boundaries of 100 milliseconds or more should be allowed by the system.

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h) A word reject capability should be provided.

5.2.2 Cursor positioning.

a) Cursors should be distinctive and easy to locate at any position on the display and should be easily tracked as it is moved through the display.

b) Cursors should not obscure, distract or impair searching for information unrelated to the cursor.

c) Cursor positions should remain stable until commanded by the user or the system to move, an explicit action should be required to enable or activate a designated cursor position.

d) Cursor controls should provide fast and accurate cursor placement; entry of a designated cursor position should be acknowledged within 0.2 seconds.

e) Control actions for cursor positioning should correspond to direction of cursor movement.

f) Where cursor positioning is required as part of a keyed data entry task, the cursor control device should be located near to, or integral with, the keyboard.

5.2.2.1 Data entry and cursor placement.

a) An ENTER action for data items should result in entry of all items regardless of where the cursor is placed on the display. The user should not be required to move the cursor to a specific field of a display to perform an enter action.

b) User required actions for cursor movement should be minimal for form-filling entry.

c) The TAB key should be used to move the cursor to the next data field.

d) The TAB key should not signify ENTER or acceptance of field contents.

e) Formats should be organized to minimize positioning movements of the cursor. If there is a predefined HOME position for the cursor, it should be consistently positioned on displays of the same type.

f) Users should not be able to move cursors to data fields which cannot accept data or where existing data cannot be modified.

Data entry - Cursor positioning

5.2.2.2 Gross positioning/pointing.

a) If proportional spacing or variable sized characters are used, the system should automatically place the cursor in the correct position for entering or changing data.

b) When cursor positioning is accomplished in discrete steps, consistent movement magnitudes should be provided for horizontal steps and vertical steps. However, horizontal steps do not need to be of the same magnitude as vertical steps.

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c) When cursors are used in selecting display areas (pointing to menu items, etc) a large area for pointing should be provided, including the area of the displayed text label, plus a half-character distance around the label.

d) When cursor positioning is the sole or primary means of data entry (as in menu selection), a direct pointing device (e.g., a light pen) should be used in preference to incremental stepping or slewing controls (e.g., keys or joystick).

5.2.2.3 Precise positioning/pointing.

a) Where precise pointing is required, as in graphics generation, a point designation feature should be provided.

b) A continuously operable control (such as a joystick or mouse) should be used to control direct pointing, rather than discrete controls (e.g., cursor control keys).

5.2.2.4 Multiple cursors.

a) Use of multiple cursors should be avoided unless indicated by user task requirements.

b) Where multiple cursors are used, they should be visually distinctive.

c) An indication of cursors which are active should be provided.

d) Where separate control is provided for multiple cursors, pointing/control operations should be compatible.

5.2.3 Text entry.

a) Adequate display capacity (number of lines and line length) should be provided to support text entry and editing.

b) When possible, the system should automatically default to a standard text input format. When users can define text entry formats, they should be capable of being stored for future use.

c) Frequently used text segments (for example distribution lists) should be separately stored and should not require keying when needed.

Data entry - Text entry

d) Information required for text entry or editing, such as user guidance information, should be separately displayed on the display medium, and should be distinct from entered or displayed text.

e) As required by the system and the user task, auditory signals should be provided to alert the user to direct attention to the display.

5.2.3.1 Cursor movement.

a) When entering or editing text, users should be able to freely move the cursor within a displayed page, to specify items for change, and to make changes directly to the text, and should be

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able to move cursors by specific units of text, such as by paragraph, line, page, and character.

b) Users should not have to frequently alter hand positions between a pointing device (such a joystick) to position cursors and the keyboard to edit or add text.

5.2.3.2 Editing.

a) Users should be able to specify units of text in editing and other control tasks; e.g., "Delete-Word", "Move-Paragraph", and "Print-Page".

b) Users should be able to select and move sections of text within a document. Text specified for control entry, e.g., "Delete-Paragraph" should be highlighted or otherwise indicated.

c) Easy to use commands, such as MOVE, COPY, and DELETE, for adding, inserting, or deleting text segments should be provided. ROLL and SCROLL commands should refer to the display window such that the display window appears as an aperture moving over stationary text.

d) Editing actions should be reversible, by use of an UNDO function.

e) An explicit action should be required to delete sections of text.

5.2.3.3 Page formatting.

a) Easy means for users to specify page formats (margins, tabs, etc.) should be provided.

b) The system should provide automatic line breaks when entered text reaches right margins. Automatic word-wrap should be provided (carriage returns should not occur in the middle of words).

c) Hyphenation should only occur by user specification.

d) Page breaks should be under the control of the user; for example, specifying the number of lines that must appear in a paragraph on a page.

e) Entered text should be left justified, and consistent spacing provided between words, unless otherwise specified by the user.

Data entry - Text entry

f) Natural units of text should be provided, e. g., by paragraphs, pages, and report sections.

g) Control entries which are displayed in text (such paragraph indentation symbols, printer commands such as begin and end underline, etc) should be distinguishable from the main text.

5.2.3.3.1 Pagination.

a) The system should provide automatic pagination, while providing the user the capability to specify page size.

b) If automatic repagination is not provided, a warning message should be presented to the user.

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c) Users should be able to override automatic pagination and be able to specify page numbers, at any point in a document.

d) The system should automatically increment pages at any point after the user specifies a beginning page number.

e) Inserting text into a paginated document should not result in loss of information.

5.2.3.4 Searching text.

a) Character string search capability should be provided (e.g., FIND 'CASREP') and should automatically locate the cursor at the occurrence of any matched strings.

b) Upper and lower case should be ignored, unless specified by the user.

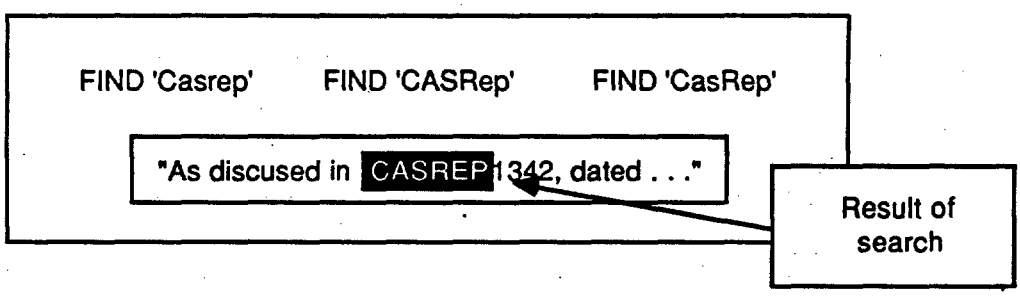

FIGURE 27. Examples of case insensitive search items.

c) A global search and replace capability should be provided. For example, a user should be able to command the system to locate all occurrences of the string "respond" and replace all occurrences with the string "response".

d) Users should be able to specify upper and lower case matches in global search and replace (e.g., REPLACE 'chief' with 'Chief') transactions.

5.2.3.5 Printing.

a) A display mode should be provided which displays text exactly as it will be printed (for example, underlining, accurate line and page breaks, font characteristics).

b) Printout options should be selectable (spacing, margins, fonts, etc) as well as portions of text to be printed.

c) The status of selectable printout options should be available to the user for review and change, and printout status information should be displayed for the user, including acknowledgment of print command, print queue information (for shared printers), and printer information (for example, printer on-off line, paper supply, printer location, form location).

5.2.4 Form entry.

5.2.4.1 Format.

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a) A unique, standard symbol (such as an ">" or code (such as inverse video) should be used for prompting data entry.

b) Hardcopy forms that are used for inputting, updating, or correcting data should correspond to screen display in terms of order of entry, data grouping, etc.

c) Where no source documents or forms exist to support data entry, data fields should be logically grouped, by sequence and frequency of use, importance, and functional associations.

d) When entry of data in a field is deferred or omitted, the system should identify the field by highlighting or other means and the user should be informed that data have not been input.

5.2.4.1.1 Field definition/delimiters.

a) Separate data items should be entered without the need for user input of separators or delimiters. If a user input field delimiter is needed, a standard symbol, such as a slash (/) should be used.

Delimiters not required
Day: [ ]
Month: [ ]
Year: [ ]

Delimiters required	
POOR	BETTER
060587	25/5/83
87|05|06	25-12-87
6.5.87	3:2:52

FIGURE 28. Examples of data field delimiters.

Data entry - Form entry - Format

b) Special characters (such as underlining, data field "boxing") should be used to delineate data fields and data field lengths.

c) Data entry by overwriting a set of characters within a field should be avoided, deletion/insertion should be used instead.

d) Users should not have to remove unused underscores or otherwise enter keystrokes for each position within a variable length entry area.

e) Optional vs. required data entries within fields on input forms should be distinct.

Required, fixed length entry [ ]

Optional entry [ ]

Variable length entry [. . . . .]

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FIGURE 29. Examples of data field coding.

5.2.4.1.2 Data field/labeling.

a) Data fields should be labeled consistently, uniquely and adjacent to the data input area. Labels for data fields should be visually distinctive, (by color, size, font, etc.) from data fields, prompts, and other information of displays.

b) Formats should be consistent (e.g., by spacial relation to associated data field, color, fonts, size, location).

c) Data field labels should appear in upper case only, while entered text may appear in both upper and lower case.

d) Unless required for user form design, field labels should not be editable by users.

e) Field labels should terminate with a special symbol (e.g., a colon) to signify data entry point.

f) Data fields should be descriptively worded by whole words (preferred) or predefined terms, codes, or abbreviations (acceptable).

g) Arbitrary codes, such as numbering schemes, should be avoided.

Data entry - Form entry - Format

5.2.4.1.2.1 Units of measurement.

a) When units of measurement are consistent within a field entry, field labels should identify the appropriate units.

b) Units of measurement familiar to the user should be used.

c) Where alternative units of measurement may be required for input, an associated field or field modifier should be provided.

d) The user should not have to transform units at time of data entry.

	Lbs X 1000	Metric tons	Long Tons
Input Aircraft Weight:		23	

Accept input as 23 Metric tons? (Y or N):

FIGURE 30. Alternate means to input units sensitive data.

5.2.4.2 Cursor positioning.

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a) When a new or blank form is presented to the user, the cursor should be positioned at the beginning of the first entry field.

b) User cursor positioning should be minimized.

c) Where the number of fields is limited, screen traversal distances are short, and when data fields will be accessed sequentially, explicit tabbing (using TAB or cursor control keys) should be available for advancing to subsequent fields.

d) In complicated forms with many fields, or when field entry will be less predictable (as in data base update), direct pointing devices, such as mouse or lightpen, should be available for selecting fields.

e) The user should not be able to position the cursor within protected fields (fields may be protected as a function of level of authorization, or reserved for display of computed values, etc.).

5.2.4.3 Data entry/editing.

a) When entering logically related items (e.g., personnel information sorted by state of residence and last name), the system should only require entry of information which changes through subsequent forms, and this information should be located at the end of the form filling transaction.

Data entry - Form entry - Format

b) Users should be able to REVIEW, CANCEL, or BACKUP to any field and change any item prior to taking a final ENTER action.

c) For variable length field entries, automatic justification of the input data should be provided.

d) Unless otherwise required by processing or display requirements, alphanumeric input should be left justified, and numeric input should be right justified for integer data or decimal point justified for decimal data.

e) Users should not have to provide a keystroke for every character space reserved by the field.

5.2.5 Tabular data entry.

a) Where sets of data must be entered sequentially or where data is keyed row by row, a tabular display format should be used.

b) Information input should be automatically justified, without the user having to insert blank/null characters.

c) Numeric data should be automatically right, or decimal point, justified.

d) Users should not have to input leading or trailing zeros.

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POOR	BETTER
10234100.	102341.0
5461.0030	5461.003
002.70000	2.7

FIGURE 31. Examples of poor and better numeric justification.

e) Numeric values should be displayed to level of significance required of the data regardless of the value of individual input data.

f) Every fifth row of a table should be separated by a blank line or other delimiter.

5.2.5.1 Cursor positioning/tabbing. Users should be able to tab to adjacent fields, across rows or columns.

Data entry - Tabular data entry

5.2.5.2 Labels.

a) Each row and column should be uniquely and informatively labeled and should be visually distinct from data entries.

b) Where more data fields exist than can be displayed on a single display page, row and column labels should remain along the top (or bottom) and left (or right) edges of the display.

c) Labels should not scroll off the visible portion of the display.

5.2.6 Graphics entry.

a) When entering and manipulating graphic data, pointing devices (such as mouse, trackball) should be used rather than keyboards. When pointing is used as medium for graphic input and manipulation, system control should also use pointing devices.

b) Easy means for saving and loading graphic displays should be provided. Users should be able to specify graphic display names and to review file catalogs of stored graphics.

c) When specified by the user, the system should provide automatic object alignment to an invisible rule or grid structure. The user should not have to align and space separate "objects".

d) Where possible, the system should validate graphic data input. For example, when a user attempts to fill the same graphic space with more than one object.

5.2.6.1 Cursors/pointer positioning.

a) Graphics display cursors should be distinctive and should have a point which can be used

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to select/manipulate small graphic objects.

b) Cursors should be easy to position and simple to point to display elements or locations.

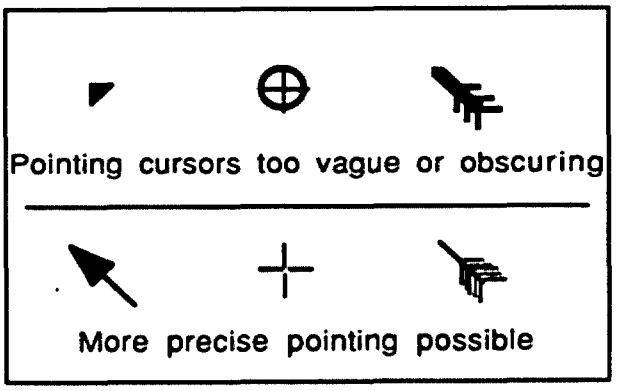

FIGURE 32. Obscure and precise graphic cursors.

Data entry - Graphics entry

c) Graphic data entry cursors should have a movement (pointing) component and an activation component; the movement component should position the cursor while the activation component should activate the cursor pointing location in order to manipulate a display element (as examples, selecting an object to be moved, drawing a line, and selecting a menu option).

5.2.6.2 Drawing.

a) Automatic grid alignment for drawn objects should be available to users at their request. Users should be able to specify grid intervals.

b) Users should be able to scale object sizes, by enlarging or reducing.

c) Users should be able to fill enclosed areas with colors or patterns.

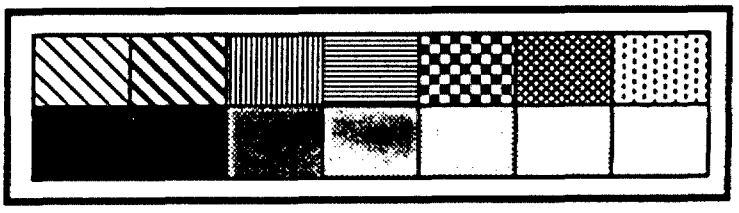

FIGURE 33. Example of fill palette options.

d) Users should be able to select automatic figure completion (e.g., automatic closure of polygons).

e) Where possible, general computer models that will allow users to generate specific from general drawings should be provided.

f) Critical or difficult graphic drawing tasks should be supported by a "zooming" function to

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enlarge critical display areas. An example of a zoom function is presented in figure 34.

5.2.6.2.1 Figure generation.

a) The system should automatically draw lines between user specified points and should support the drawing of rectangles, arcs, ovals and other figures.

b) Objects should emerge as they are being drawn. For example, when a user draws a line by moving a pen across a graphics tablet, the line displayed should emerge as the pen moves from the start point, increasing or decreasing in length and slope, as the pen moves across and around the tablet. Figure 35 presents this concept.

c) Users should be able to constrain line drawing to exactly vertical or horizontal. For precise drawing, users should be able to specify their geometric relations to other lines (e.g., parallel or perpendicular to another line).

Data entry - Graphics entry

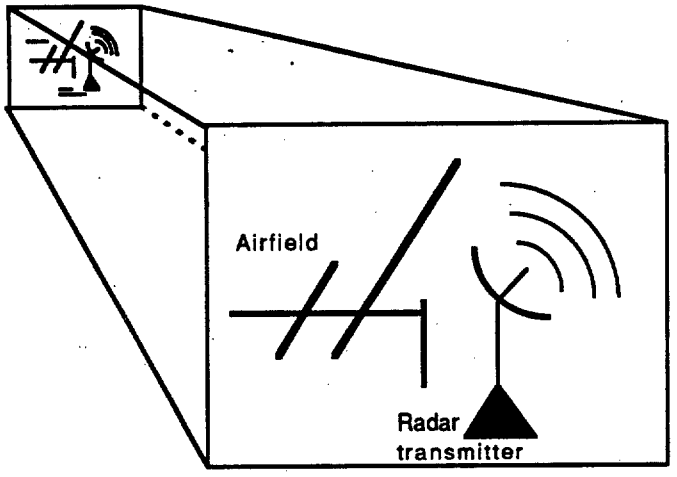

FIGURE 34. Zoom function.

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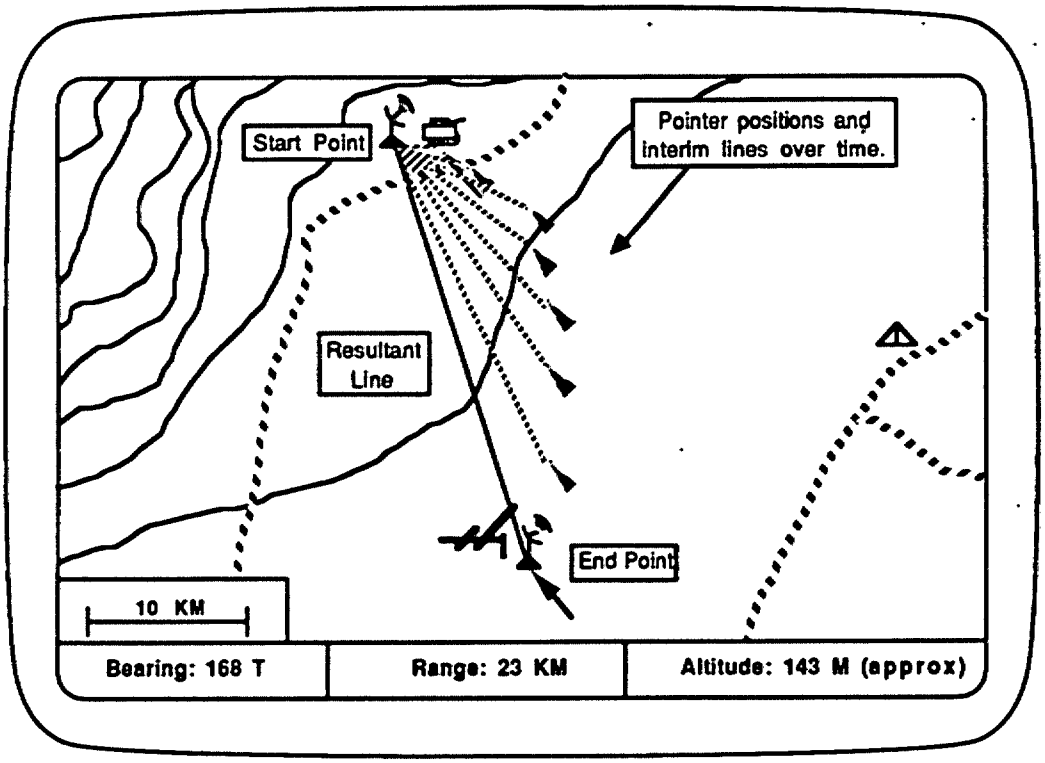

FIGURE 35. Example of object emergence during object generation.

Data entry - Graphics entry

d) Alternate methods should be provided for drawing objects.

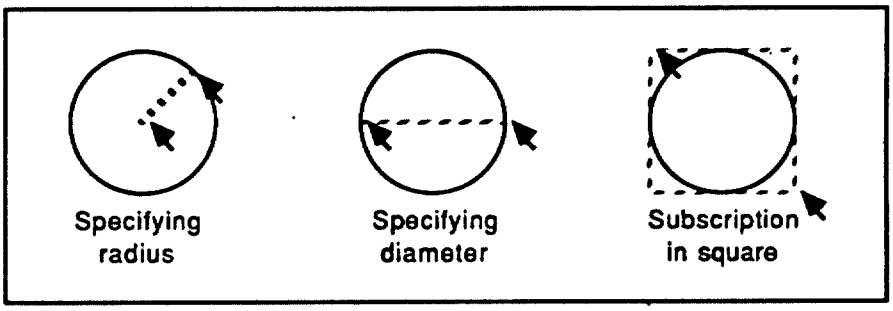

FIGURE 36. Alternate means to draw a circle.

e) Users should be able to copy (duplicate), rotate, and vertically or horizontally mirror image objects.

5.2.6.2.2 Grouping/merging objects.

a) The system should automatically merge objects and assign precedence to objects. For example, for two icons or symbols which are somewhat superimposed, the system would obscure part of the partially covered symbol. An example of this is presented in figure 37.

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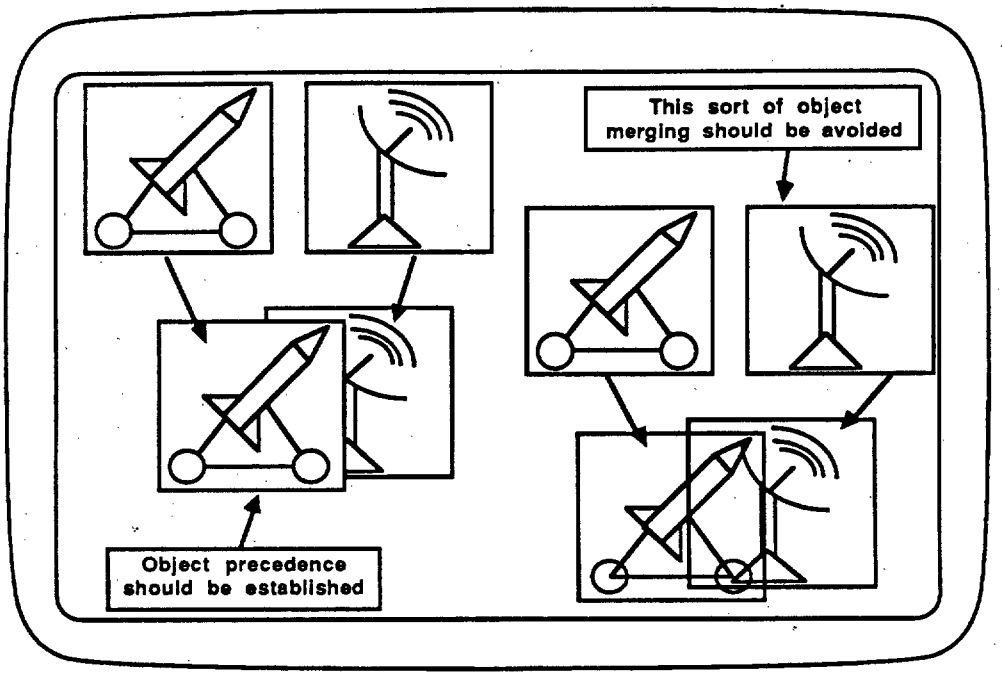

FIGURE 37. Establishment of graphic object precedence.

Data entry - Graphics entry

b) The system should provide means to group separate objects into a single, grouped object (so that separate objects may, for example, be moved as a unit, or so that a complex object can be incrementally drawn).

c) Where separately drawn lines must connect at terminal points, the system should automatically make the connections.

5.2.6.3 Graphic objects, elements and attributes.

a) Graphic display elements (e.g., color, line thickness, text fonts) should be selectable by the user for manipulation, and element attributes (e.g., blue, 1/64 inch line thickness, 12 point Lincoln-Mitre font) should be selectable and editable by pointing to and selecting from displayed examples.

b) Object attributes should be displayed as selected (using selected colors, textures, font size/shape, etc), and should not be appended to objects by codes or other means.

c) Attribute selection/editing methods should be consistent.

d) Activated/selected graphic elements should be highlighted or otherwise indicated to the user.

e) User selectable objects should be easily repositioned, duplicated, or deleted.

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Data entry - Graphics entry

5.2.6.4 Plotting data.

a) When complex graphic data must be entered quickly, computer aids should be provided. For example, when plotting data within Cartesian coordinates, the system should automatically draw lines between the specified points of a function.

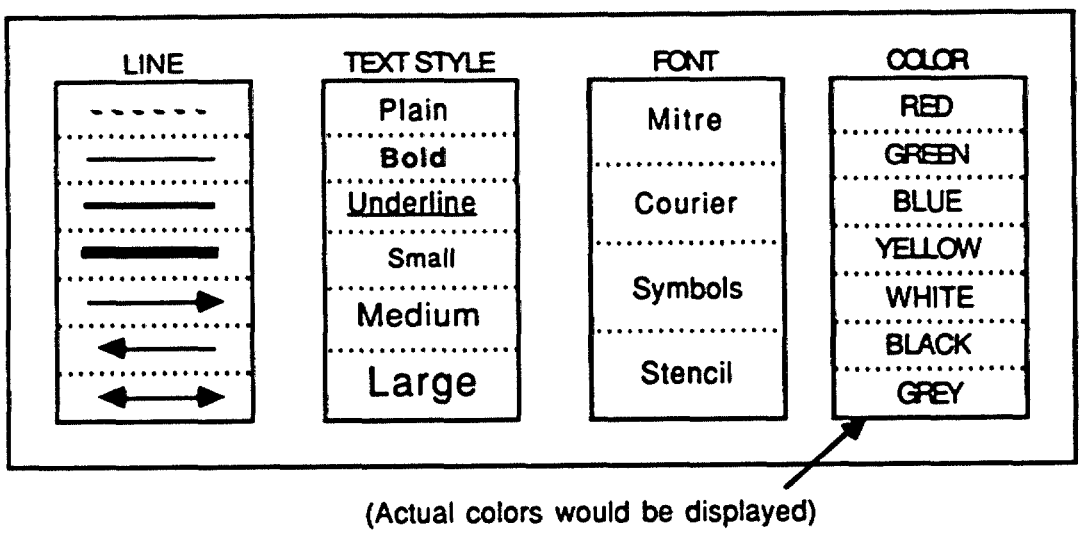

FIGURE 38. Example of graphic figure attributes and elements selection option.

b) The system/software should support automatic plotting of stored data.

c) Where frequently used or constrained graphic formats exist, the system should provide graphic templates to the user.

d) The system should provide for automatic scaling of graphic data and users should be able to modify system generated scales.

e) When graphic data can be derived from data already in the computer, machine aids should be provided. For example, automatic curve smoothing, reshaping polygons, data filtering, etc.

5.2.7 Data validation.

5.2.7.1 User validation.

a) The user should be able to obtain a paper copy (virtual screen dump) of the contents of alphanumeric or graphic displays.

b) If information is printed remotely, print status messages should be displayed and screen contents should not be changed as a result of the print operation.

c) In repetitive data entry task, inputs should be validated at the time of each transaction.

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d) For novice users, the system should provide optional item-by-item data validation within a multiple-entry transaction (e.g., at the end of every data field entry).

5.2.7.2 System validation.

a) Where possible, automatic data validation to check data for correct format should be provided. For example, a date is entered as "February 31", should generate an error message.

b) Correct data entries should always be accepted and processed properly by the computer without need for user involvement to proceed.

c) Where possible, when a data or command entry does not meet validation logic, a cautionary message should be displayed asking the user to confirm data entry.

d) If data validation detects a probable error, an error message should be displayed at the completion of a field/data entry, without interrupting an ongoing transaction.

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5.3 Data display.

5.3.1 General.

5.3.1.1 Display of information.

a) Information density should be minimized in displays used for critical task sequences. For critical information, 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.

b) Whenever possible, users should be able to see the whole page (e.g., of text, tactical map, etc.) with which they are working.

c) Data needed for a transaction should be displayed in a directly usable form, and only essential data should be displayed.

d) Users should be able to control the amount, format, and complexity of displayed data, as necessary to meet task requirements.

e) Users should be able to obtain a paper copy of the exact contents of alphanumeric or digital graphic display in systems where mass storage is limited, mass stored data can be lost by power interruption, or where record keeping is required.

f) When task performance requires or implies the need to assess currency of information, displays should be annotated with date-time information.

5.3.1.2 Consistency/standardization.

a) Data should be displayed consistently in word choice, format, and basic style, and within standards and conventions familiar to users.

b) Data display should be standardized within applications and across transactions.

5.3.1.3 Wording/style.

a) The wording of displayed data and labels should incorporate familiar terms and the task-oriented language of the users, and use of unfamiliar language of designers and programmers should be avoided.

b) Consistent wording should be provided for displays, data and labels; e.g., the word "Screen" should not be used to mean "Display Frame" in one place, and "Menu Options" in another.

c) Consistent grammatical structure for data and labels within and across displays should be provided.

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Data display - General

5.3.1.4 Labeling.

a) Each individual data group, message, or frame should contain a distinct, unique, and descriptive label.

b) Display frame labels should be an alphanumeric code, or an abbreviation which is prominently displayed and is short enough (3-7 characters) or meaningful enough to be learned and remembered easily.

c) Labels should be highlighted or otherwise emphasized. The technique used should be easily distinguished from that used to highlight or code emergency or critical messages.

d) Labels should be descriptively, consistently and distinctly worded.

e) Label locations and formats should be consistent.

5.3.1.5 Format.

a) A consistent organization of display features among displays should be adopted.

b) Different elements of display formats should be distinctive within a display, but should be consistent across displays.

c) Blank space should be used to structure a display.

d) Groups of information should be separated by blanks, lines, color coding, or other visually distinctive means.

5.3.1.5.1 Layout.

a) Display windows should be labeled at the top with a title or header which describes the contents or purpose of the display.

b) At least one blank line between the title and the body of the display should be provided.

c) Where control is exerted via keyboard, the last several lines at the bottom of every display should be reserved for status and error messages, prompts, or command entry.

d) Where users must analyze sets of data to discern similarities, differences, trends, and relationships, displays should be formatted so that the data are grouped to facilitate analysis and comparison.

e) Data fields to be compared on a character by character basis should be positioned one above the other.

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Data display - General - Layout

XRB	2D4	TY78	3401	SEG67	23W5	7YB5	2WD4
XRB	2O4	TY78	34Ø1	SEH67	23W5	7Y85	2WE4

FIGURE 39. Example of data layout which facilitates data comparison.

f) Where possible, data should be grouped by sequence, function, importance, or frequency of use, or by other means such as alphabetic or chronology.

g) Context for displayed data should be provided.

h) Visually distinctive data fields should be provided.

5.3.1.5.2 Multipage displays.

a) When a display contains too much data for presentation in a single frame, the data should be partitioned into separately displayable pages.

b) Related data should appear on the same page and relations among data sets should appear in an integrated display rather than partitioned into separate windows.

c) Each page should be labeled to show its relation to the others.

5.3.1.6 Coding.

a) Coding should be employed to differentiate between items of information, to call the user's attention to changes in the state of the system, and to indicate important, hazardous, or critical information which requires user action.

b) Coding by data category should be provided where a user must distinguish rapidly among different categories of displayed data that are distributed in an irregular way on the display.

c) Meaningful codes should be used rather than arbitrary codes. For example, use "M" for male and "F" for female rather than "l" and "2".

d) Coding should be consistent across displays. Codes assigned special meaning in a display should be defined at the bottom of the display and should replicate the code being defined.

5.3.1.6.1 Alphanumeric coding.

a) Alphanumeric coding may be used to supplement other coding schemes , but should not be used as the sole means to call attention to important or critical information.

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Data display - General - Coding

b) Alphanumeric codes should display all letters consistently in either upper or lower case.

c) When short alphanumeric codes combine both letters and numbers, letters and numbers should be grouped together rather than interspersing letters with numbers; for example: letter-letter-number ("HW5") will be read and remembered more accurately than will letter-number-letter ("H5W").

d) Arbitrary alphanumeric codes that must be recalled by the user should be no longer than four or five characters.

5.3.1.6.2 Auditory coding.

a) Auditory coding signals should be used to alert an operator to critical conditions or operations, as a means of supplementing visual display or as an alternative means of information presentation where visual display is not feasible, and as a means to provide feedback for control actuation, data entry, or completion of timing cycles and sequences.

b) Noncritical auditory signals should be capable of being turned off at the discretion of the user. A simple, consistent means of acknowledging and turning off alarm signals should be provided.

c) Auditory signals should be provided when computer response to a user request is greater than 15 seconds.

d) Signals should be intermittent in nature to allow the user sufficient time to respond. Auditory signals should be distinctive in intensity and pitch.

e) The number of signals to be identified should not exceed four.

f) 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 with the requirements of other personnel in the signal area.

g) For auditory displays with voice output, different voices should be used to distinguish different categories of data.

h) If computer-generated speech output is used for auditory display, a special alerting signal should be provided to distinguish them from routine voice messages.

5.3.1.6.3 Brightness intensity coding.

a) Brightness intensity coding may be used to differentiate between adjacent items of information or to code two to three state conditions. Brightness coding should have only one meaning (e.g., ON-OFF or FAST-SLOW, or STANDBY-RUN, but not all three).

b) Each level of brightness coding should be separated from the next nearest level by a 2:1 ratio and should discriminate only between two categories: bright and dim.

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c) "Inverse video" may be used to highlight critical items that require user attention. When used, brightness inversion should be reserved exclusively for that purpose and not used for general highlighting.

Inverse video to code important information
VS. normal video which does not stand out

FIGURE 40. Coding by inverse and normal video.

5.3.1.6.4 Color coding.

a) Color coding, where appropriate, should be used to differentiate between classes of information in complex, dense, and critical displays.

b) The following reserved color meanings should be used:

RED should be used to indicate conditions such as "no-go", "error", "failure", "malfunction", etc.

FLASHING RED should be used only to denote emergency conditions requiring immediate operator action, or to avert personnel injury, equipment damage, or both.

YELLOW should be used to indicate marginal conditions or to alert situations where caution, recheck, or unexpected delay is necessary.

GREEN should be used to indicate that monitored equipment/processes are within tolerance or a condition is satisfactory and that it is all right to proceed with an operation or transaction.

WHITE should be used to indicate system conditions that do not have operability or safety implications, but indicate alternative functions (e.g., "Printer #2 on-line").

BLUE may be used as an advisory color, preferential use of blue should be avoided.

c) Color may be used to identify data categories when it does not conflict with other color coding conventions and does not conflict with the color associations specified above. Use of color as a formatting code should be subordinate to other methods.

d) Color coding should be redundant to some other means of coding such as symbology; coding only by color should be avoided.

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Data display - General - Coding

e) Color coding should not be used if the information will be accessed from monocromatic displays or hardcopy printouts, or if users may be deficient in color perception.

f) Colors should be easily discriminable and color coding should be used conservatively. Each color should represent only one category of displayed data.

g) Brighter or more saturated colors should be used when it is necessary to draw a users attention to critical data.

5.3.1.6.5 Flash coding.

a) Flash coding should only be used to display an urgent need for user attention.

b) No more than two levels of flash coding should be used. Flash rate in the range of 3 to 5 Hz should be used with equal "on" and "off" intervals. If two flash coding levels are used, the second should flash at less than 2 Hz.

c) When a displayed item is blink coded, a flashing marker symbol (such as an asterisks) should be used rather than blinking the item itself.

d) Event acknowledgment or flash suppression keys should be provided.

5.3.1.6.6 Line coding.

a) Line coding by color, including variation in line type (e.g., solid, dashed, dotted) and line width ("boldness") should be used. An example of line coding is presented in figure 41.

b) Underlining may be used to indicate unusual values, errors in entry, and data changes. Underlining rather than overlining should be used.

c) Coding by line length should be used for applications involving spatial categorization in a single dimension (e.g., velocity, acceleration vectors).

d) Coding by line direction should be used for applications involving spatial categorization in two dimensions, (e.g., target bearing).

5.3.1.6.7 Pattern/location coding. Pattern and location coding may be used to reduce search time by restricting the area to be searched to prescribed segments.

5.3.1.6.8 Shape/symbol coding.

a) Symbol coding should be used to enhance the transfer of information.

b) Symbols should be analogs of the event or system elements they represent, be in general use and well-known to the users, and be based on established standards or conventional meanings.

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Data display - General - Coding

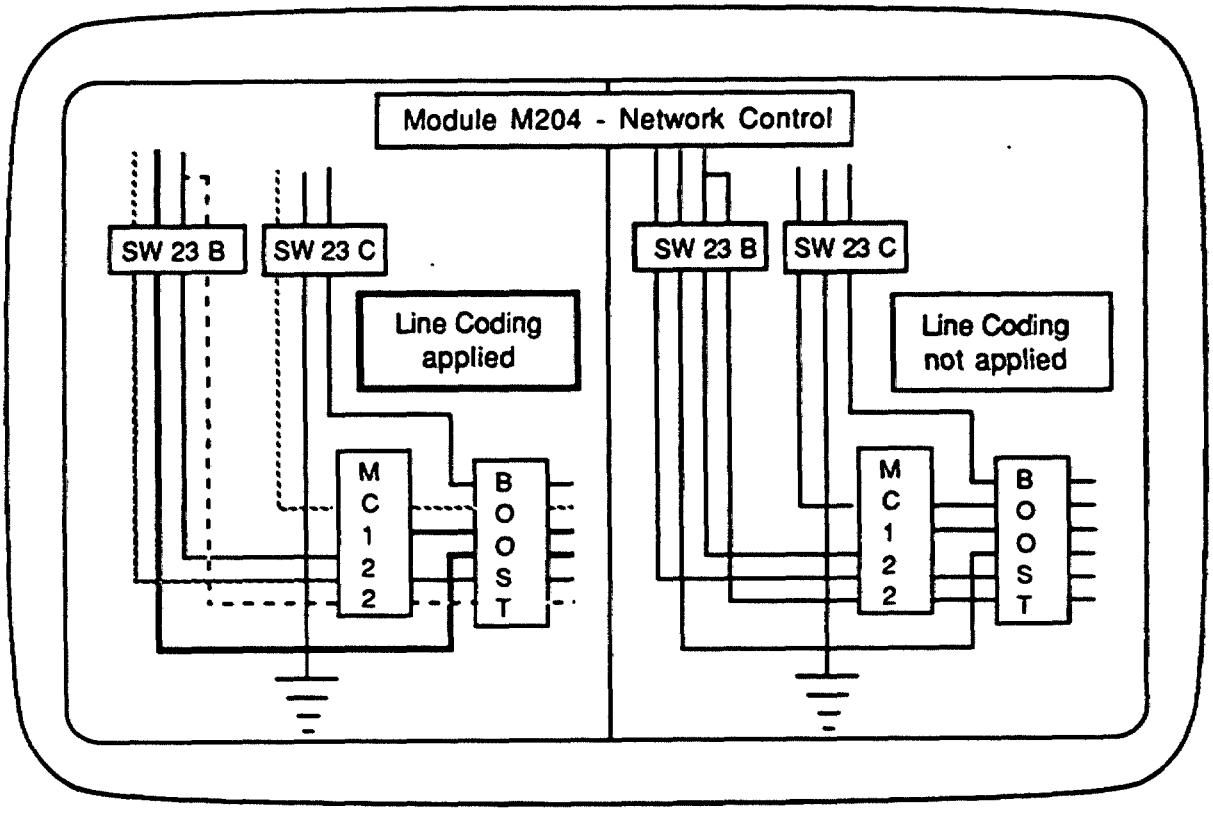

FIGURE 41. Example of line coding.

c) Symbol heights should not differ more than three sizes.

d) Special symbols, such as asterisks, arrows, etc., may be used to draw attention to selected items in alphanumeric displays.

e) Use of special symbols should be consistent and their meanings unique.

f) Shape codes using more than 15 different shapes should be avoided. Component shapes may be used in combination (for example, symbol modifiers such as velocity-direction vectors).

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Data display - General - Coding

5.3.1.6.9 Size coding. When used, size coding should not exceed 3 sizes. For size coding, a larger symbol should be at least 1.5 times the height of the next smaller symbol.

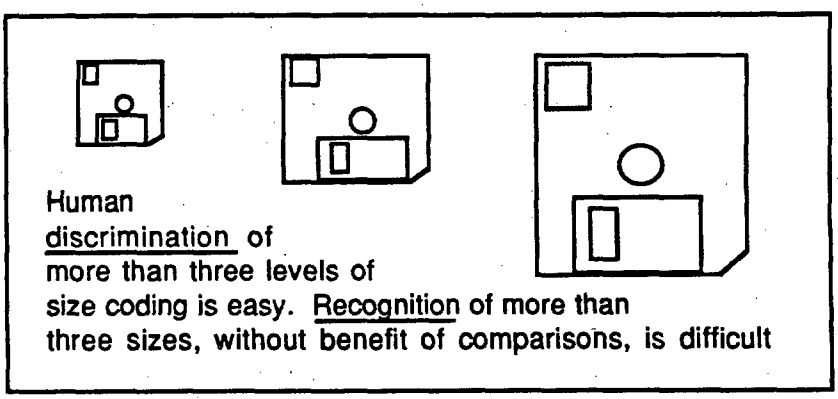

FIGURE 42. Three easily recognizable sizes.

5.3.2 Display control.

a) Users should be able to tailor information displays by controlling data; selection, coverage, updating, and suppression, and should be able to specify data for display. An easy means to return to normal display coverage should be provided.

b) Users should be able to control displayed data or enter new data when required by a task.

c) As required, users should be able to print paper copies of information displayed.

d) Users should not be required to remember data accurately from one display page to another.

5.3.2.1 Display of control options.

a) Screen control locations and control options should be clearly and appropriately indicated.

b) When a user is prompted by the system for a parameter with a predefined fault, the default value should be shown.

c) Information that the user must have to manipulate displays should be displayed as the control becomes available.

5.3.2.2 Data accession.

a) A consistent and easy means of moving through data should be provided by windowing, panning, paging or scrolling.

Data display - Display control

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b) Paging and windowing should not be used when searching through continuous text data.

c) Panning and scrolling should not be used when searching logically grouped information (as in data forms).

5.3.2.2.1 Scrolling. Scrolling, rather that paging, should be used for reading continuous text or lists.

5.3.2.2.2 Pan and zoom.

a) When a display exceeds capacity of a single frame, users should be able to pan a display frame.

b) When a user may need to view data relations, pictures, diagrams, maps, etc., in detail, a zooming capability should be provided.

c) When a display has been expanded by zooming from its normal coverage, a scale indicator of the expansion should be provided.

d) Panning and zooming functions should be integrated with scales and other overlayed data, such as scaled marks, range vectors, etc.

e) An overview position of an expanded section of a display should be provided as a user reference to position within a display. An example of zoom with position reference information is presented in figure 43.

5.3.2.2.3 Information suppression.

a) Temporary suppression of displayed data may be provided when information is not needed to support task conduct. Information suppression should be indicated on the display.

b) An indication of changes of significant suppressed data should be provided.

c) Users should be provided with means to quickly restore suppressed data to the display.

5.3.2.3 Labeling and marking information.

a) When a user can select/manipulate data displays, each display should have an identifying label and other identifying information to support display control and data access.

b) Identifying labels should be located in a prominent and consistent location and should be unique, short and meaningful.

c) Annotating displays of continued data should be provided; e.g.,

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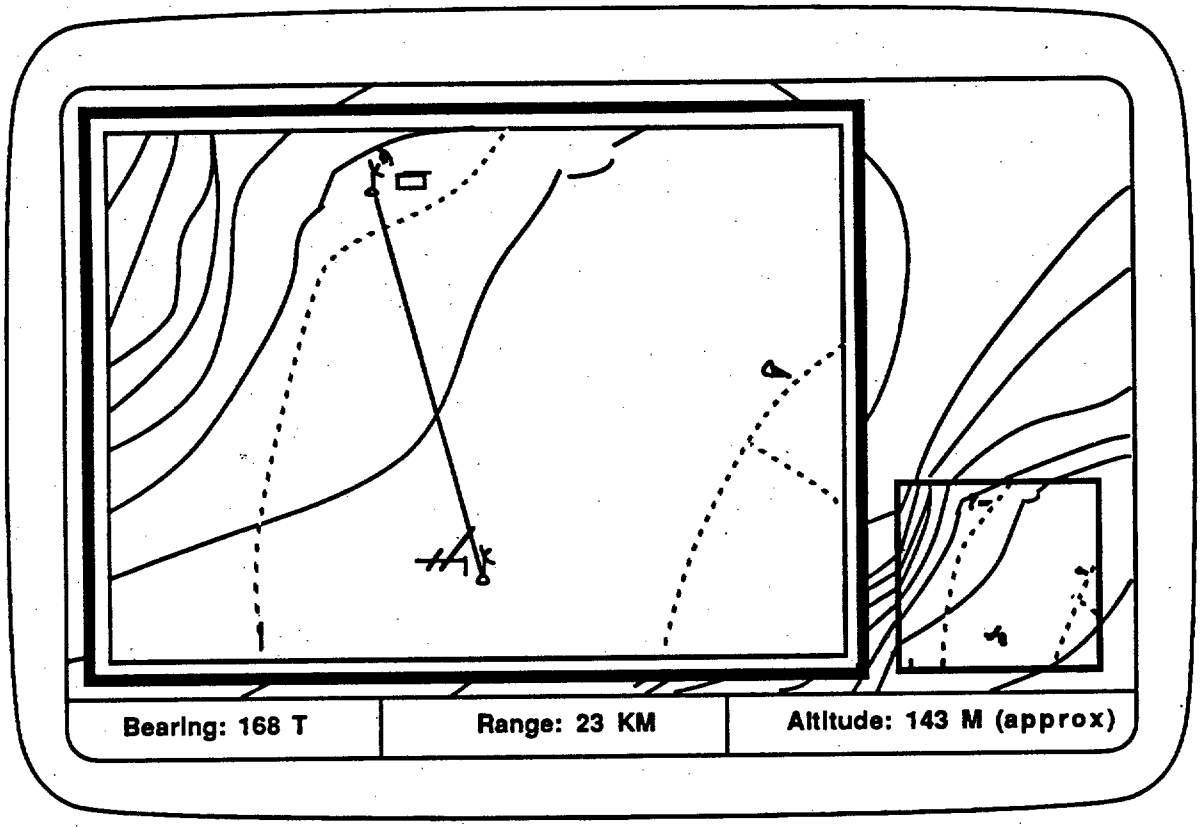

FIGURE 43. Example of zoom with position reference information.

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d) Paging vs. scrolling labels should be consistently distinct and unambiguous; e.g., UP may be used to scroll up a line within a frame and PREVIOUS to go to a preceding page.

e) Labeling for display paging should be referred to in functional terms; (e.g., FORWARD and BACK, or NEXT and PREVIOUS).

f) When lists of numbered items exceed one display page, items should be numbered continuously in relation to the first item on the first page.

5.3.2.4 Display regeneration/data update.

a) Where users must accurately read changing data (e.g., target range, bearing, speed), the data should be displayed long enough to read to the level of precision required.

b) Rate of display regeneration should not exceed user perceptual and information processing capabilities.

c) Changing alphanumeric data which must be reliably or accurately read should not be updated more often than once per second.

d) When the information displayed is to be considered real time, changing values which are used to identify rate of change or to read gross values should not be updated faster than 5 times per second, nor slower than 2 times per second.

5.3.2.4.1 User/system control.

a) Unless directed by task, system, or mission requirements (as in tactical displays), users should be able to initiate display regeneration (e.g., "Redraw Now", or "Recompute Now").

b) The rate of information update should be controllable by the user and should be determined by the use to be made of the data.

c) When data is changed via automatic processing (as in real time sensor data processing and display), data updates should be temporarily highlighted or otherwise marked.

5.3.2.4.2 Freeze frame.

a) When displayed data are automatically updated, users should be able to "freeze" the display to examine changed data more deliberately.

b) When frozen, the display should clearly be labeled, and users should be warned if some significant data change has occurred due to subsequent processing or sensing (as in radar sweep updates).

c) When resuming update after display freeze, display update should resume at the current real-time point unless otherwise specified by the user.

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5.3.2.4.3 Data extrapolation. When needed, a prediction display extrapolating dynamic display information should be provided; for example, distribution of air forces in 10 minutes given current bearing, velocity, acceleration, etc.

5.3.3 Voice displays. Voice displays may be used to supplement visual displays when communication flexibility is necessary, when coded signal meanings are numerous or may be forgotten, for presentation of complex directions or instructions, when ambient noise may mask simple tonal signals or in conjunction with tonal signals, and for presentation of continuous information where rate of change is low.

5.3.3.1 Word selection.

a) Words selected should be appropriate to the task/information presented, concise, and intelligible.

b) Where possible, words that rhyme and may confuse message interpretation should not be part of the spoken lexicon, or should not be presented within the same message.

c) Use of slang should be avoided.

d) Words with more than one syllable should be used.

e) Alphanumeric data should be presented using phonetic alphabets, e.g., "Whiskey Zebra three two seven" should be used in preference to "WZ327" where the "Z" and "3" are too phonetically similar.

5.3.3.2 Presentation.

a) Spoken messages should be produced in the form of the "average talker", in an American English accent without regional dialects.

b) Speech intensity should be appropriate to the expected ambient noise environment. Within a typical office space intensity should be approximately 70 to 75 dB sound pressure level. Signal to noise ratios should be at least 5:1. Audio signal power should be approximately 300 milliwatts at the listeners ear. Speech signals should fall within the range of 200 to 6100 Hz.

c) Spoken warning messages should be preceded by an alerting signal. Users should be required to acknowledge spoken warning signals.

d) Messages should be brief, informative, and to the point.

5.3.4 Windows.

a) Window overlays may be provided to temporarily add data (such as help screens, menus, or other features) to a display, or as a means to control or display divergent information, or to segregate and control separate operations.

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b) The display screen should be capable of displaying each of the windows simultaneously, in either a tiled or overlapped format, as requested by the user.

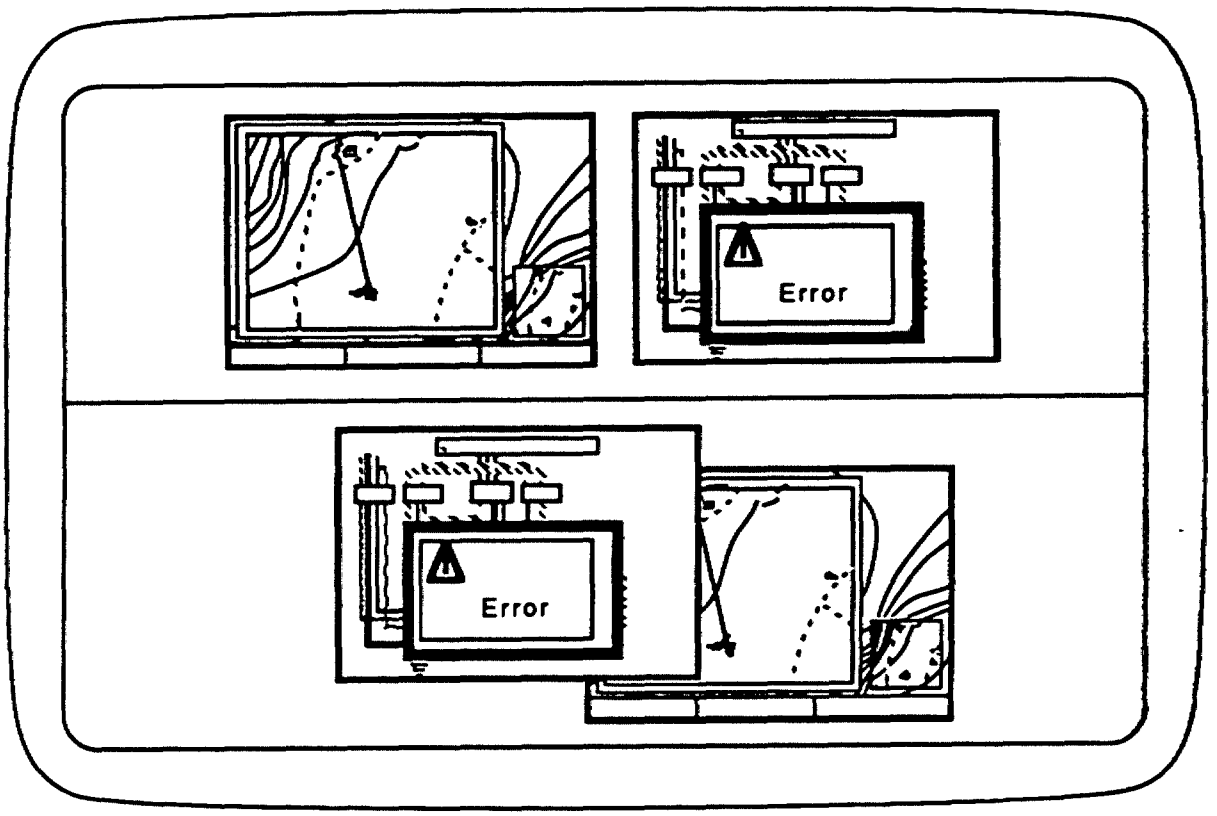

FIGURE 44. Example of tiled vs. overlapped windows.

c) Windows should be predefined and displayed under user control, as appropriate (e.g., user acknowledgment of an alert window, help screen calls, etc.).

d) Window overlays should be nondestructive and should not permanently erase overlayed data. See figure 45.

5.3.4.1 Format.

a) Default formats should represent the "configuration" of the information to be displayed (i.e., whether the information conforms to the standard tile format), and the expectations and experience of the typical user.

Data display - Windows

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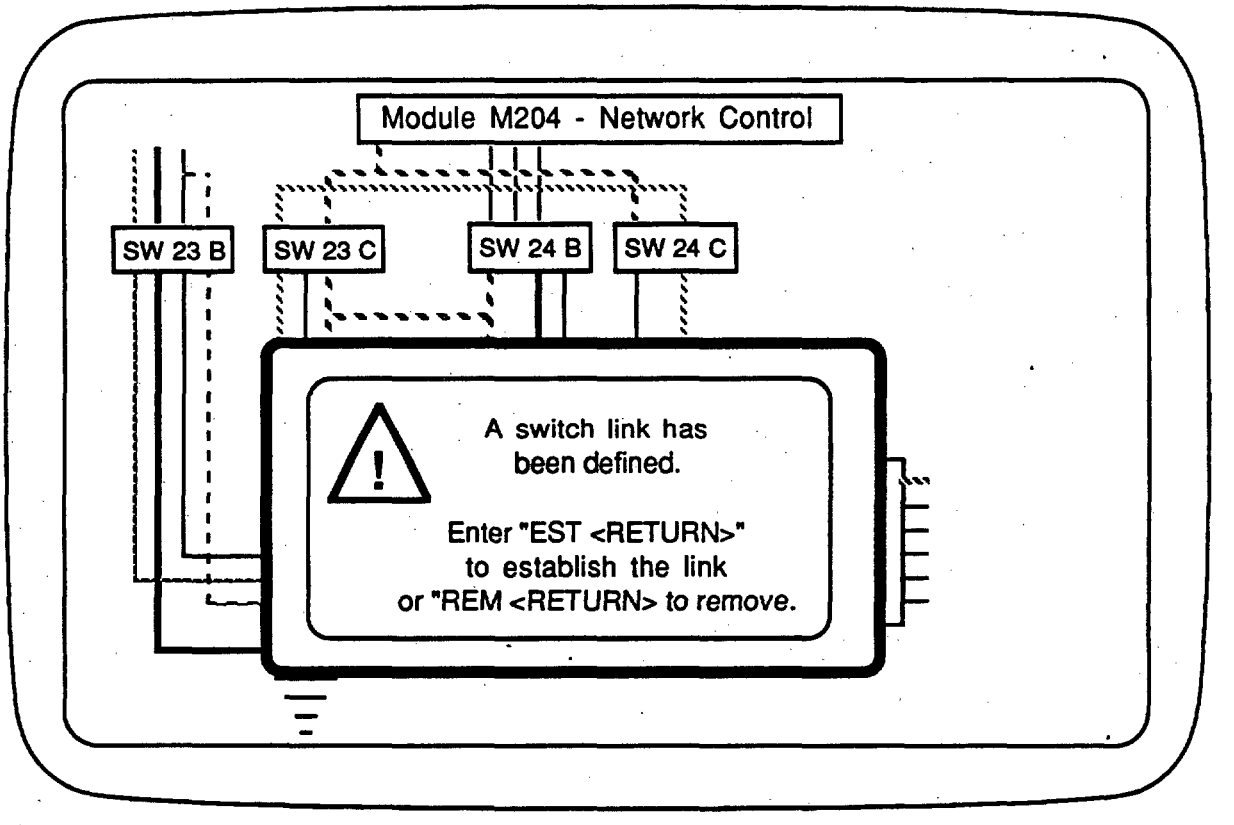

FIGURE 45. Example of a window overlay.

b) The size and shape of the initial presentation of a window should be consistent with its contents (amount of information, number of menus, data fields, etc.).

c) Windows which are dedicated to command entry by keyboard input should be located at the bottom of the display area.

5.3.4.2 Labeling and identification.

a) Windows must be visually separated from each other and from their background, preferably by borders or similar demarcation.

b) Windows should be identified by a label consistently located at the top of the window's border. Where several windows can be displayed at one time, active windows should be indicated by labeling or other means, and an easy means of shifting among windows should be provided.

c) Labels should remain on the screen while the data scrolls beneath them (e.g. the headings on a chart).

Data display - Windows

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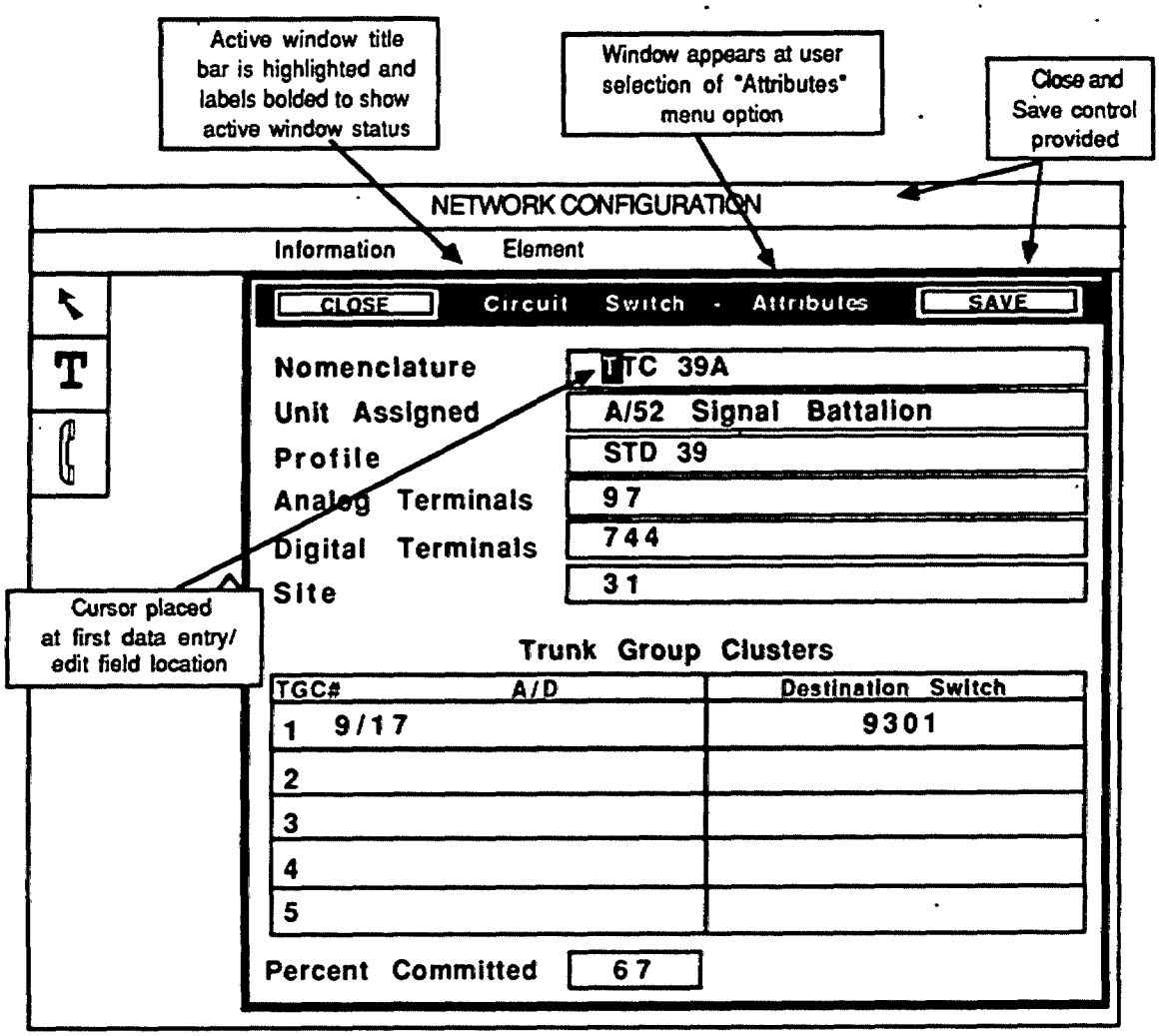

FIGURE 46. Elements of window design.

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Data display - Windows

5.3.4.3 Operation. In addition to the guidelines below, the guidelines of Section 5.3.2 "Display Control" should also apply.

a) Windows should be consistent in terms of command syntax and semantics. Control of window operations should be consistent throughout the system.

b) As appropriate to the user task, windows should be capable of the following operations: scrolling/panning, resizing, moving, hiding, activating, deactivating, copying to/from, zooming in/out, tabbing, and undo-last.

c) For text-only windows and windows used for scanning data, window sizing should be constrained such that the smallest possible window will contain at least 2 lines of text /data. Each window should have variable line widths (e.g, 80-160 characters) selectable by the user.

d) Keyboard input should affect only the active window designated by the user.

e) Users should be able to specify and select separate data windows that will share a single display frame. The system should provide the user several options for moving between active windows (e.g., clicking a mouse button, tab, cursor keys, or function key).

f) Within a session, the system should keep track of the windows that are open (but not necessarily active or displayed) and display them as a menu.

g) Automatically updated windows should have display freeze capability. When a window displays automatically updated information, the user should have control over the rate at which automatically updated screens are scrolled .

h) A window that is not displayed should be capable of sending and receiving information.

5.3.4.4 Feedback.

a) The system should provide immediate and unambiguous feedback concerning which active window is being acted upon.

b) When the user is communicating with a closed window (e.g., sending or receiving information between windows), the system should provide feedback that clearly designates the window(s) involved.

c) If windows are capable of different modes (e.g., real-time data display, recap, command input/selection, etc.), the system should provide immediate and unambiguous feedback concerning which mode is active.

d) When a display is frozen (e.g., while executing a Print Screen command), the system should provide immediate and unambiguous feedback and the user should be prompted to return to automatic update. A warning flag should be displayed to alert the user to significant changes in real-time data that occurred while the display was frozen.

Data display - Windows

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e) If a user-requested action (e.g., closing a window) would result in lost or damaged data, the user should be alerted and alternative actions recommended. See figure 47.

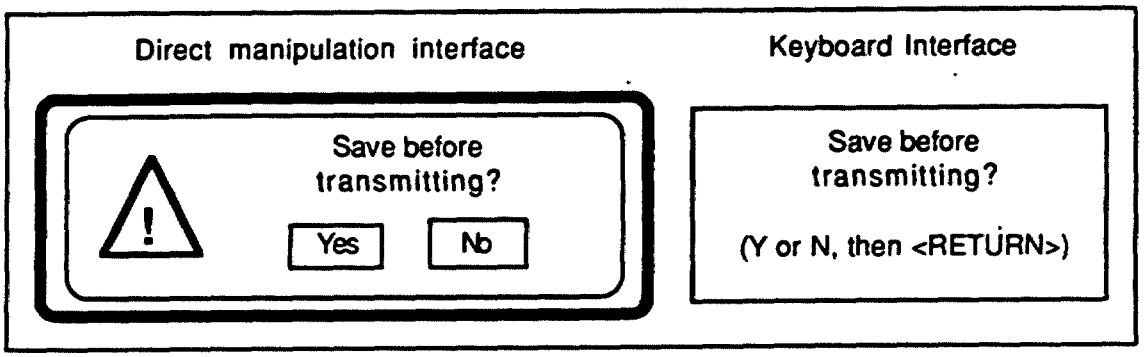

FIGURE 47. Acceptable feedback windows, with prompting response to user command.

f) The system should be capable of alerting the user to critical information that becomes available in an inactive or nondisplayed window. See figure 49.

5.3.5 Data forms. Forms should be used to display related sets of data in separately labeled fields.

5.3.5.1 Format.

a) Visually distinctive fields should be provided.

b) When forms are used for data entry as well as for the data display, the format for data display should be compatible with whatever format is used for data entry. The same item labels and ordering for both should be used.

c) The ordering and layout of corresponding fields should be consistent among displays.

5.3.5.2 Data presentation.

a) Units of measurement for displayed data should be presented in the label or as part of each data item.

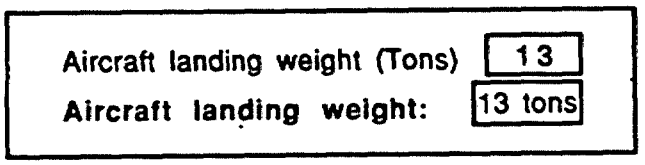

FIGURE 48. Two means of providing data element units.

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Data display - Windows

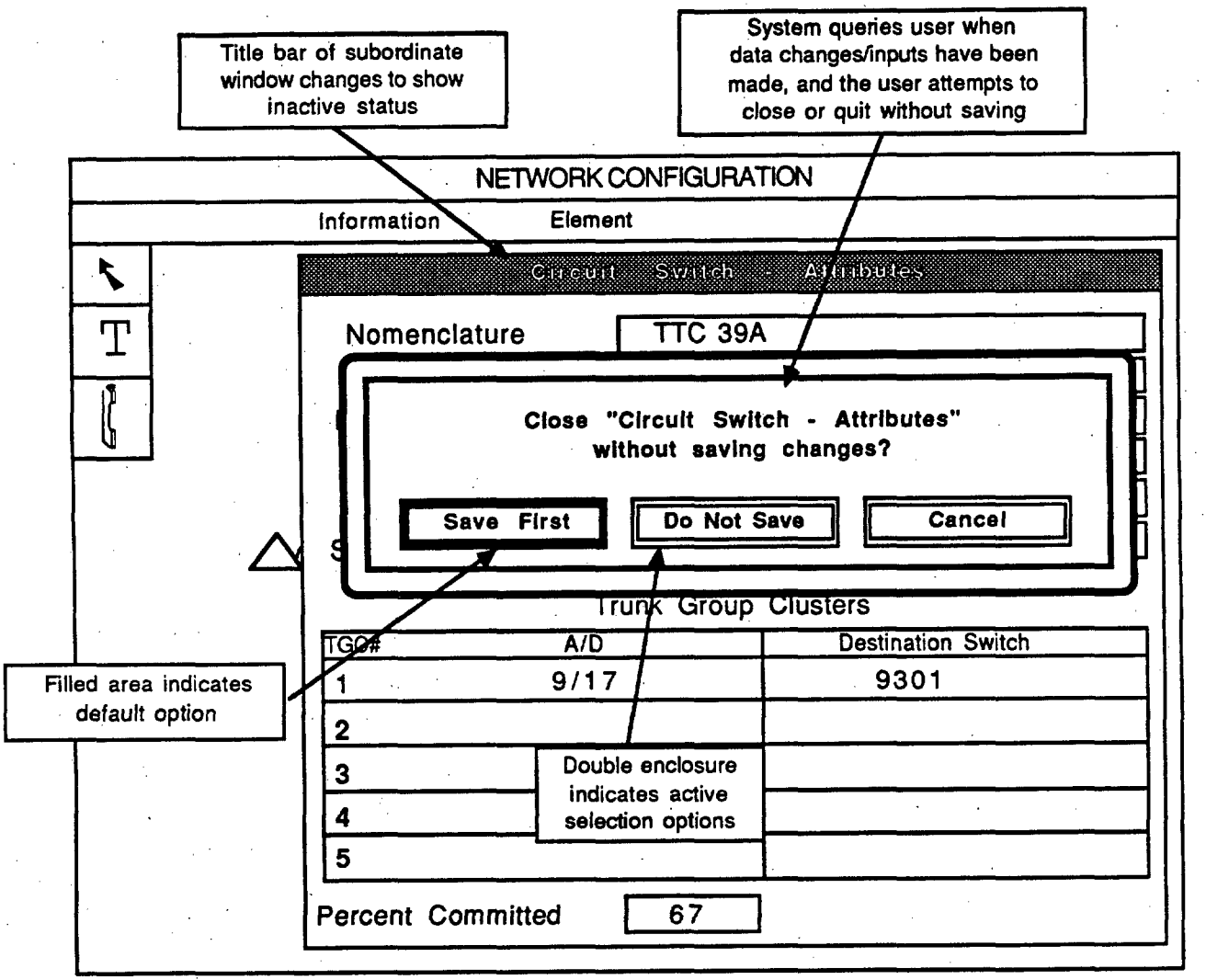

FIGURE 49. Example of window feedback and prompting.

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b) Long data items of mixed alphanumeric characters should be divided into subgroups of three or four characters separated by a blank or by other symbol.

c) The internal format of frequently used data fields should be consistent from one display to another; as examples, telephone numbers should be consistently punctuated, (703) 698-6225, time records consistently punctuated with colons, as HH:MM:SS: or HH:MM or MM:SS.S, and date as DD:MM:YY.

d) Blanks (keyed spaces) should be distinguishable from nulls (no entry at all) in the display of data forms.

5.3.5.3 Data field labels. Each data field should be identified with a display label which is located close to the data fields they identify.

5.3.6 Text.

5.3.6.1 Format.

a) Consistent text formats should be provided from one display to another, and should conform to MIL-STD-490.

b) When tables and graphs are associated with text, they should be placed as closely as possible after the first reference within the text.

c) Information should be placed in groups to permit the user to associate or compare similar classes of information. Grouping may be accomplished by right or left justification of columns to establish boundaries of group areas, spacing between groups, lines between group areas or under group headings, and locating items to be compared character-by-character in subsequent lines on the display.

d) When words in text displays are abbreviated, each abbreviation should be defined in parentheses following its first appearance.

e) Critical passages/information should be highlighted by bolding/brightening, color coding or other means. Capitalization alone should not be used.

f) Where possible, series of related text should be displayed in a list rather than as continuous text.

5.3.6.1.1 Lists.

a) Unless dictated by the amount of information to be presented, or where information is to be composed, lists should be formatted so that each item starts on a new line.

b) When a single item in a list continues for more than one line, items should be marked so that the continuation of an item is obvious.

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Data display - Text

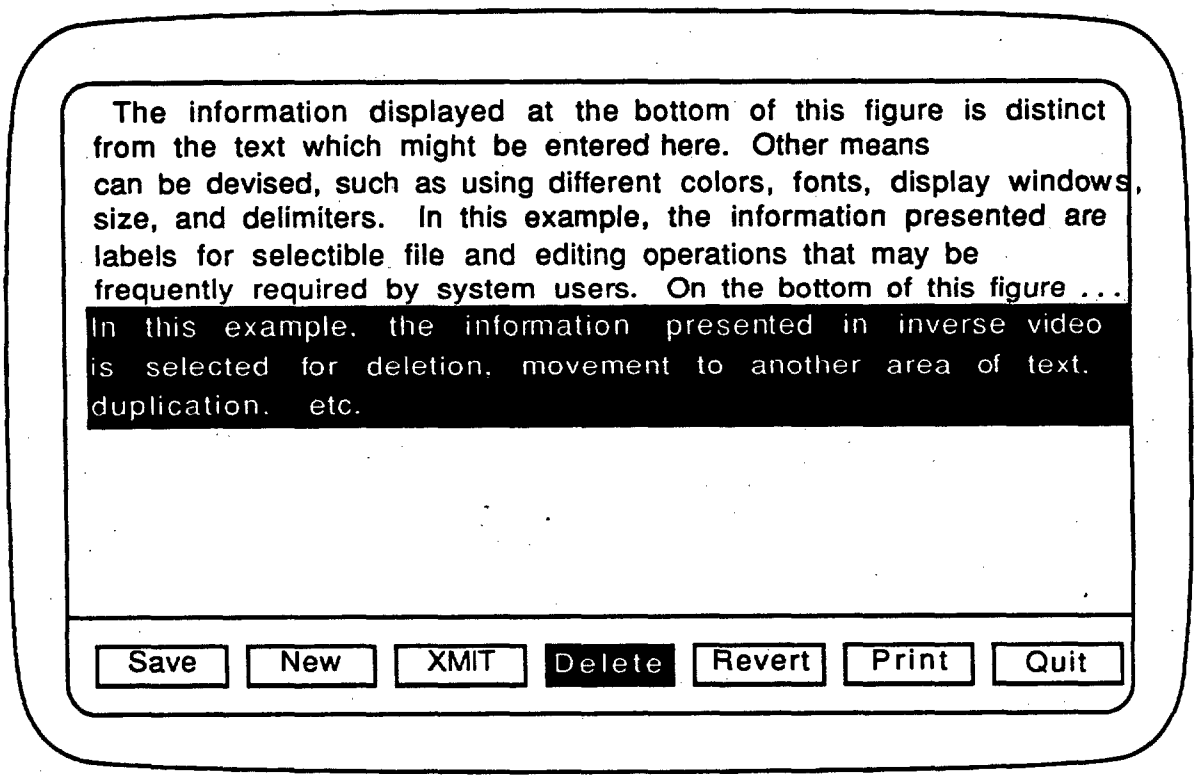

FIGURE 50. Example of text highlighting.

c) When five or more alphanumeric characters without natural organization are displayed, the characters should be grouped in blocks of three to five characters within each group separated by a minimum of one blank space or other separating character such as a hyphen or a slash.

d) Column spacing within a table and from one table to another should be uniform and consistent.

e) Item numbers should begin with one, not zero. Numbering should start with one when it applies to counting and with zero when it applies to measurement.

f) Lists should be arranged in a recognizable order, such as cronological, alphabetic, sequential functional, or importance.

g) Where a list is displayed in multiple columns, the items should be ordered vertically within each column.

h) For a long list extending more than one displayed page, the last line of one page should be

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the first line of the next page.

Data display : Text - Format

i) For hierarchical lists, such as outlines, complete identifiers (e.g., "Paragraph 4.2.2.4.8") should be used rather than omitting the repeated elements (e.g., "Subparagraph 8").

j) Identifiers should not be indented, but titles and subtitles should be indented so that their structure is apparent.

5.3.6.1.2 Free running text.

a) Lengthy textual material (over several display screens) should be displayable in hardcopy form rather than requiring the user to read it on-line.

b) When a user must continuously read text on-line, at least four lines of text should be displayed at one time.

c) Text should be presented in mixed upper and lower case.

d) Text should be formatted in a few wide lines containing at least 50 characters per line, rather than in narrow columns of many short lines.

e) Displayed paragraphs of text should be separated by at least one blank line. Paragraphs should be numbered.

f) Consistent spacing between the words of displayed text should be provided with left justification of lines and ragged right margins. Left and right justification may be used if it can be achieved by variable spacing, maintaining constant proportional spacing between and within words, and consistent spacing between words in a line.

g) Computer-generated displays of textual data, messages, or instructions should follow design conventions for printed text.

5.3.6.2 Wording/style/punctuation.

a) Text displays and text composed for user guidance should be concisely, clearly and simply worded, and simple sentence structures should be used.

b) Distinct words rather than contractions or combined forms should be used in displayed text.

c) Where possible, affirmative statements rather than negative statements should be used, and sentences should be composed in the active rather than passive voice.

d) When a sentence describes a sequence of events, it should be phrased in that order.

e) Use of hyphenation should be minimized and conventional punctuation should be used.

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Data display - Text

5.3.6.3 Display control.

a) When the user is scrolling vertically through text, the present and end locations should be displayed on the viewable portion of the display; e.g., "lines 24 through 46 of 428 lines".

b) Speed of text display should be controllable and should not exceed the users normal reading speed.

5.3.7 Tables.

5.3.7.1 Format.

a) In tables with many rows or columns, a blank line, dots, or other distinctive features should be inserted after every third to fifth row or column. The columns in a table should be separated by blank spaces, or by some other distinctive feature.

b) Tabular data should be organized in a consistent, recognizable pattern. Tabular data should be displayed in a left-to-right, top-to-bottom array.

c) When tabular data extend over one page vertically, the columns should be labeled identically on each page. Tabular data should not extend horizontally over more than one page.

c) Consistent spacing within a table, and from one table to another, should be maintained.

AN-UQQ Parts control

Part Name:	Part Number	Bin Number:	Units
Power supply, 28 VDC	M34 564	234	5
Signal amplifyer	G34 672	814	8
Signal converter	344 W34	332	7
Transmitter cable	W88 909	448	1
12 Pin connector	RS4 445 2	129	1
Connector adapter	MTO 344	786	0
Switching unit	R34 556 7	550	5
Antenna assembly	344 56 334	878	8
Antenna mounts	342 998	134	3
Boost circuits	FR4 55	512	12
Shipping cradle	D34 BBF	451	5
Seal package	TS4 455	560	8
Meter, 0-32 VDC	W88 909	094	1
Test circuit	RS4 445 2	562	2
Remote readout	MTO 344	886	1

FIGURE 51. Example of tabular data spacing.

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5.3.7.1.1 Numeric data.

a) 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.

b) Columns of numeric data should be justified with respect to a fixed decimal point. If there is no decimal point, then numbers should be right-justified.

c) In presenting decimal numbers, trailing zeroes should be presented to the level of significance of the number.

d) For hierarchical lists with compound numbers, complete numbers should be displayed.

5.3.7.1.2 Alphanumeric data.

a) When five or more alphanumerics are displayed, without a precedent grouping organization (as in telephone numbers, serial numbers, vendor part numbers, etc), characters should be grouped in blocks of three to four characters. If a series is to be 10 units, then its structure should have distinct groups of 3, 4, 3. Groups should be separated by a minimum of one blank character.

b) When grouping alphabetic characters, acronyms or abbreviations should be used in preference to randomly selected characters that have little relevance to the system.

c) Complex coding systems should use a combination of alpha and numeric designators and grouping should be applied. For example:

POOR	BETTER	BEST
954891282	945 891 282	A54 L91 Z28

FIGURE 52. Format for complex numbering systems.

d) Columns of alphabetic data should be left justified.

5.3.7.1.3 Reference tables.

a) When tables are used for reference, items should be located in the left column, and display the material most relevant for user response in the next adjacent column. Associated but less significant material should be displayed in columns further to the right.

b) All displayed data necessary to support a user activity or sequence of activities should be grouped together.

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Data display - Tables - Format

c) When data fields contain a naturally occurring order; e.g., a chronology, such order should be reflected in the organization of the field.

5.3.7.1.4 Data comparisons. A tabular format for data display should be used when information handling requires detailed comparison of ordered sets of data. Where data items must be compared on a character-by-character basis, data should be vertically structured.

POOR						BETTER			
	A			B		A	243	WQ4	113
453	E63	902	453	363	902	B	243	WU4	113

FIGURE 53. Two means to format data to be compared (A and B).

5.3.7.2 Labeling/identifying data.

a) Each individual field should be labeled. The user should not have to rely on contextual clues alone to identify a field. Table row and column labels should be presented in terms familiar to the user.

b) Labeling units of measurement should be part of column labels, or placed after the first row or column data entry.

5.3.8 Graphics.

a) Graphics displays should be used when displaying data showing relations in space or time, when users must quickly scan and compare related sets of data, or when users must monitor changing data; e.g., bearing angles, environmental conditions.

b) Consistent logic, standard formats, and labeling should be provided each method of graphic presentation.

c) Graphically displayed information should be limited to user information needs and task requirements. Critical data should be highlighted.

d) When needed to view graphics, pictures, diagrams, or maps in detail, zooming capability should be provided. When a display has been expanded from its normal coverage, a graphic indicator of the position in the overall display of the visible section should be provided.

e) A scale should be provided for maps and related displays.

f) When on-line graphic displays must be printed, users should be able to display the material exactly as it will appear in the printed output.

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5.3.8.1 Format.

a) Label formats should be consistent; for example, labels consistently placed over the displayed points with which they are associated.

b) As needed to support user tasks, reference indices, baselines and text annotations should be included in graphic displays. Textual data annotation should be provided where precise information is required.

c) Normal orientation for labels should be used; e.g., labels should be displayed horizontally for the vertical axis of a graph.

5.3.8.2 Coding and symbology.

a) Symbol meanings should be standard and should look like the objects or processes they represent.

b) When used, simple texture codes should be used rather than elaborate patterns.

c) Where possible, the movement of data elements under computer control should have an animation quality.

d) Where sequential relations between display elements requires highlighting, animation may be used; for example, connectivity might be emphasized by an arrow moving repeatedly between two displayed elements.

5.3.8.3 Curves and line graphs.

a) Curves and line graphs should be used for displaying relations between two continuous variables, as in showing data changes over time.

b) Unless required, use of three-dimensional scales should be avoided.

c) Curve and line graphs should convey enough information to allow the reader to interpret the data without referring to additional sources.

d) When curves must be compared, they should be displayed in one combined graph.

e) Figure and title elements should be clearly identified.

5.3.8.3.1 Axes.

5.3.8.3.1.1 Design.

a) The horizontal (X-axis) should be used to plot time or the postulated cause and the vertical (Y-axis) should be used to plot a caused effect.

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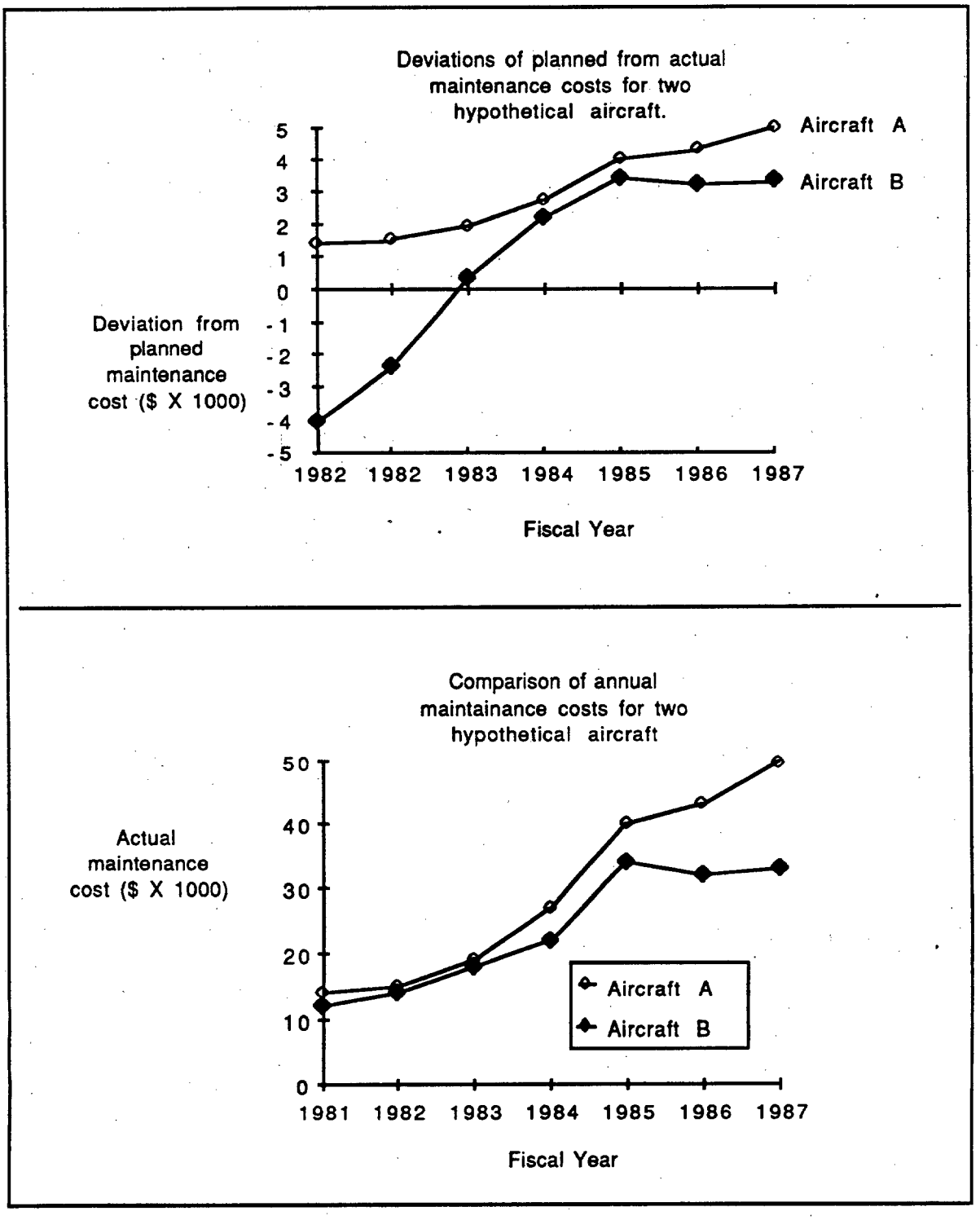

FIGURE 54. Examples of computer generated line graphs and their chracteristics.

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b) When graphed data represents only positive numbers, the graph should be displayed with the origin at the lower left. When the data include negative values and the axes extend in both directions from a zero point, the origin should be displayed in the center of the graph.

c) Unless required for classification, use of broken axes should be restricted.

d) When scaled data will contain extreme values, the X-axis should appear at both the top and bottom, and the Y-axis should appear at both the left and right sides of the graph, and grid lines should be provided.

5.3.8.3.1.2 Markings and labels.

a) Values on an axis should increase as they move away from the origin.

b) Both the X-axis and Y-axis should be clearly labeled with title, symbol (as appropriate), and units.

c) Logical, mathematical subdivisions should be indicated along each axis. Each axis interval should be marked; but to avoid clutter, usually only every other interval (major division) is marked.

5.3.8.3.2 Scales.

a) Each scale axis should be labeled clearly with its description and measurements units.

b) Where users must compare graphic data across a series of charts, the same scale for each chart should be used. When users must compare aggregate quantities within a display, or within a series of displays, scaling of numeric data should begin with zero.

c) Graphs should have a single scale for each axis. Where possible, common scales for complex graphics should be provided.

d) Linear scales should be used in preference to logarithmic or other non linear scales.

e) Except where convention or customary divisions exist, scales should be constructed with graduations at standard intervals of 1,2, 5, or 10 (or their multiples by 10) for labeled divisions. Intervening graduations should be consistent with the labeled scale interval.

5.3.8.3.3 Legends. Where possible, each curve within a single graphic should be identified directly by an adjacent label, rather than by a separate legend. If a legend is displayed, the codes should be ordered in the legend to match the spatial order of their corresponding curves in the graph itself.

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Data display - Graphics - Curves and line graphs

5.3.8.3.4 Multiple curves.

a) In charts displaying multiple curves, curves representing data of particular significance should be highlighted.

b) Line coding to distinguish curves should be provided. Consistent line codes should be used to represent corresponding data in a series of charts.

c) Curves representing planned, projected or extrapolated data should be distinguishable from solid curves representing actual data. Where curves must be compared to a critical value, a reference index in the chart should be provided. Where users must evaluate the difference between two sets of data, a difference curve should be displayed.

d) Where curves represent cyclic data, extending the graph to repeat uncompleted portions of the displayed cycle may be provided.

5.3.8.3.5 Surface charts.

a) When curves represent all of the portions of a whole, surface charts may be used to display aggregated amounts. The areas defined below the curves should be textured or shaded.

b) Data categories in a surface chart should be ordered such that the least variable curves are displayed at the bottom and the most variable at the top.

c) Where space permits, areas of surface charts should be labeled directly within the textured or shaded bands.

d) Cumulative curves may be used to show cumulative totals. Cumulative curves should not be used to extract quantitative or rate of change data.

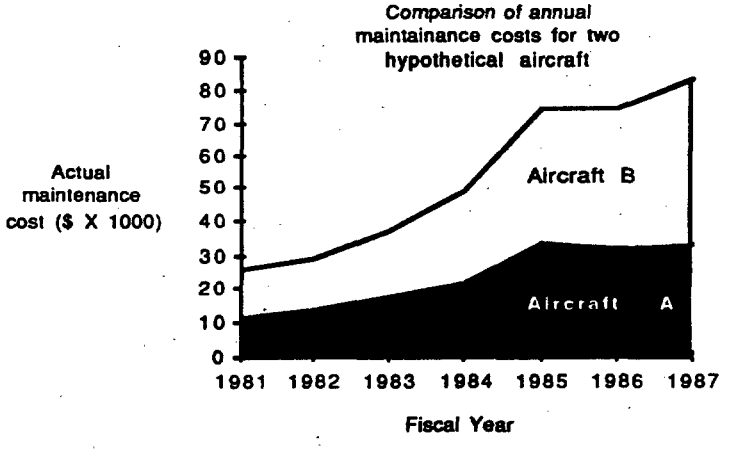

FIGURE 55. Example of a surface chart.

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5.3.8.3.6 Grids.

a) When necessary grids, should be provided to aid in data interpretation.

b) Grids should be unobtrusive, thinner than data curves, and should be invisible behind depicted objects and areas such as the bars on a bar chart.

5.3.8.4 Bar charts and histograms.

a) Bar graphs may be used when comparing a single measure (e.g., number of eligible recruits, thousands of dollars, etc.) across a set of several entities (e.g., geographic regions, level of education, religion, etc.) or for a variable sampled at discrete intervals.

b) Histograms (bar graphs without spaces between the bars) may be used when there are a great many entities or intervals to be plotted.

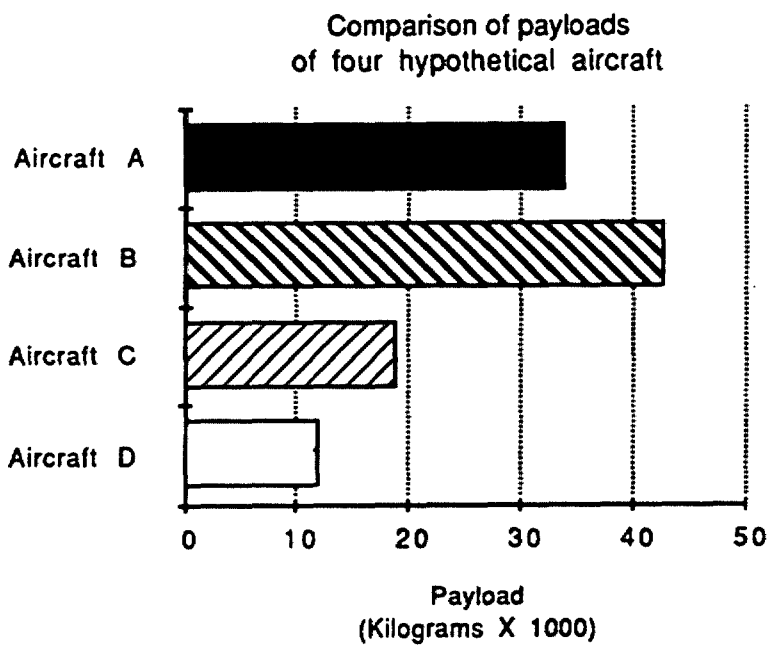

FIGURE 56. Example bar chart.

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Data display - Graphics - Bar charts and histograms

5.3.8.4.1 Format.

a) In a related series of bar graphs, a consistent orientation of the bars (vertical or horizontal) should be adopted.

b) When data must be compared, bars should be adjacent to one another. Adjacent bars should be spaced such that a direct visual comparison can be made without eye movement.

c) A reference index should be provided when displayed values must be compared with some critical value.

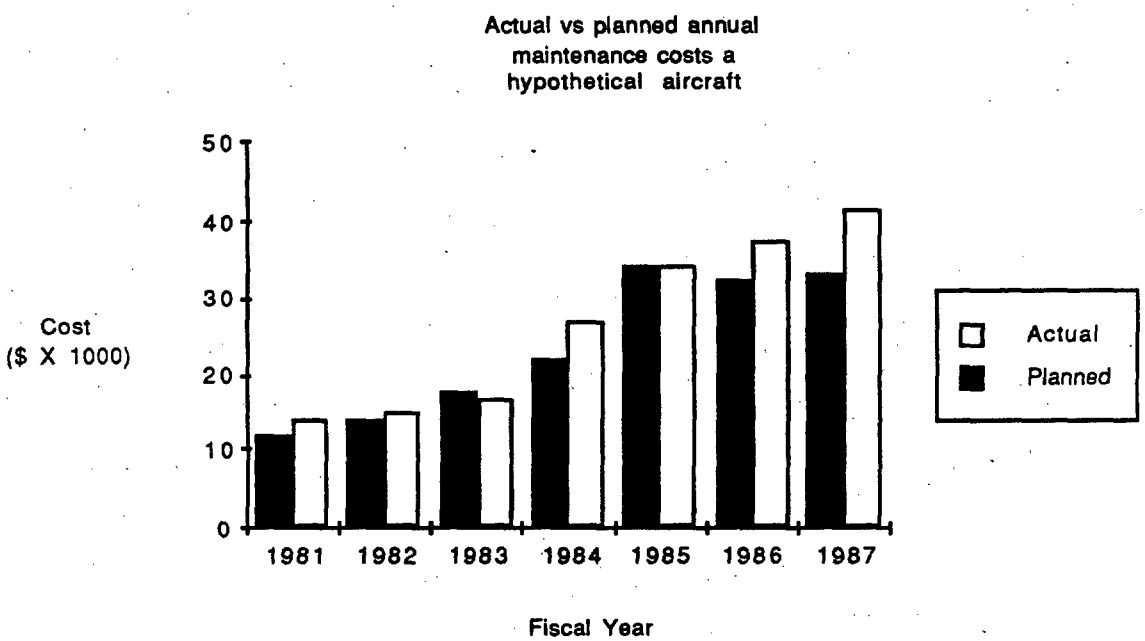

FIGURE 57. Example of a bar chart which facilitates data comparison.

d) Stacked bars (total measures broken down by segments) may be used. Order of segment stacking should be by variablilty of each segment, with the least variable segment being the lowest or leftmost segment, and the most variable segment being the highest or rightmost segment.

e) Use of iconic representations of quantitative information, such as when a silhouette of a person represents 1000 people, should be avoided.

5.3.8.4.2 Coding/labeling.

a) Charts and axes should be clearly labeled.

b) Important, critical or frequently referenced information should be highlighted.

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c) When bars are displayed in pairs, they should be labeled as a unit, with a legend or individual distinguishing labels for each bar.

5.3.8.5 Flowcharts. Flowcharts may be used for schematic representation of sequences or processes, as an aid to problem solving.

5.3.8.5.1 Format.

a) Flowcharts should be ordered so that displayed steps follow a logical order; (e.g., a process by sequence of activity or by decreasing importance to mission success).

b) When there is no inherent logic in a flowchart, steps should be ordered to minimize flowchart size.

c) The displayed path of flowcharts should be from left to right, from top to bottom, or clockwise.

d) Decision points should require a single, simple decision.

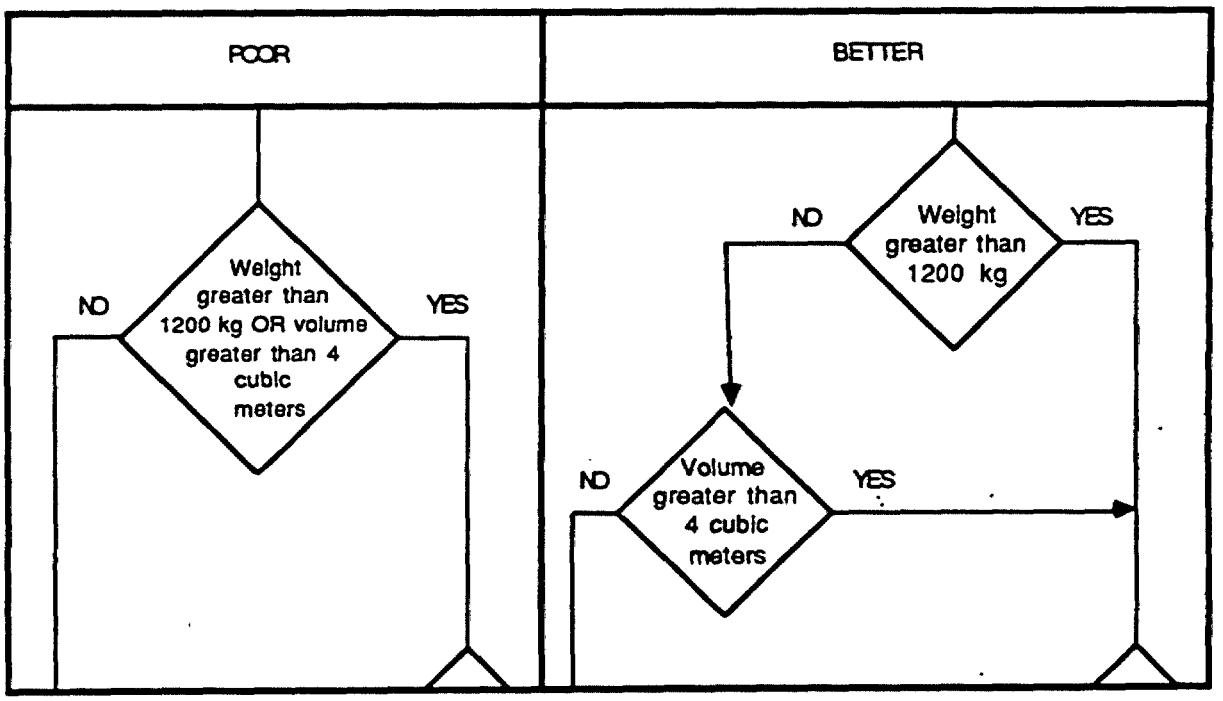

FIGURE 58. Decision block complexity.

e) Decision options should be logically ordered.

f) Decision block outcome paths should be consistent.

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Data display - Graphics - Flow charts

5.3.8.5.2 Coding/labeling.

a) Symbol/shape coding and line coding should be used to assist in identifying elements and flow lines. For different types of flowchart elements, a consistent coding scheme should be followed.

b) Legends should be displayed on each figure and title and each element should be clearly labeled.

c) Critical steps/processes in a flowchart should be highlighted.

5.3.8.6 Maps and situation displays. Maps and situation displays should be used to display geographic data, i.e., direction and distance relations among physical locations.

5.3.8.6.1 Format.

a) Orientation of maps and situation displays should be consistent or under user control (for example, oriented to true north, magnetic north, or vehicle direction).

b) When maps present large geographic areas, a consistent method of projecting the earth's curvature on a flat display surface should be specified and adopted (e.g., mercator projections or equal area projections).

c) Distance judgments from map displays should be supported through grid overlays, pointing devices, or other means.

5.3.8.6.2 Coding/marking/labeling.

a) When it can be done without cluttering, significant features of a map should be labeled directly on the display.

b) When different areas of a map must be defined, or when the geographic distribution of a variable must be indicated, color or other means of coding should be provided.

c) Where users must make relative judgments for different colored areas of a display, tonal codes rather than spectral codes should be used.

d) Texture, pattern or tonal variation coding should be selected so that the darkest and lightest shades correspond to the extreme values of the coded variable.

e) Highlighting should be used to represent data of particular significance.

5.3.8.6.3 Data presentation.

a) Where possible, demographic or other data on map displays (population density, troop strength, etc.) should be presented graphically rather than by using text descriptions.

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b) When it is necessary to show the geographic location of changing data (e.g., troop movements), auxiliary graphic elements (such as symbols) should be combined with a map background.

c) A stable reference for changing data should be provided.

d) When map or situation data categories are variable, the user should be able to select the categories needed for information presentation. For example: in monitoring aircraft for collision avoidance, a user might choose to display aircraft tracks within a particular sector and altitude zone.

e) Complex data analysis (such as determination of sight lines using a map display) should be supported by computer processing.

5.3.8.6.4 Display control.

a) When a map exceeds the capacity of a single display frame, in terms of extent and detail of coverage, panning rather than paging over the area should be provided.

b) When a user pans over an extended display, an indication of the position in the overall display should be provided.

5.3.8.7 Pictures and diagrams.

a) Pictorial displays should be used to show representations of real or imaginary objects or processes; (e.g., photo interpretations, panel layout concepts, map overlays).

b) Diagrams should be used to show spatial relations, with selective focus on the data specifically required by a user's task where a full pictorial rendering might be unnecessarily complicated. Figure 59 presents an example of a picture display.

5.3.8.7.1 Coding/labeling.

a) Abstract symbols and iconic representations may be used to denote objects within pictures and diagrams.

b) Symbols should be standardized and a legend defining symbols should be displayed or available at user option. See figure 60.

c) Picture or diagram data of particular significance should be highlighted.

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Data display - Graphics - Pictures and diagrams

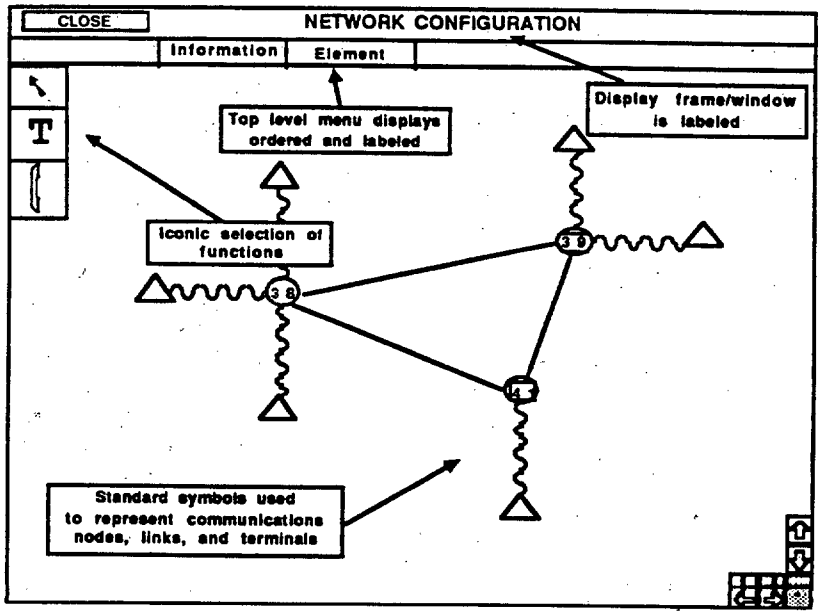

FIGURE 59. Example of a picture display.

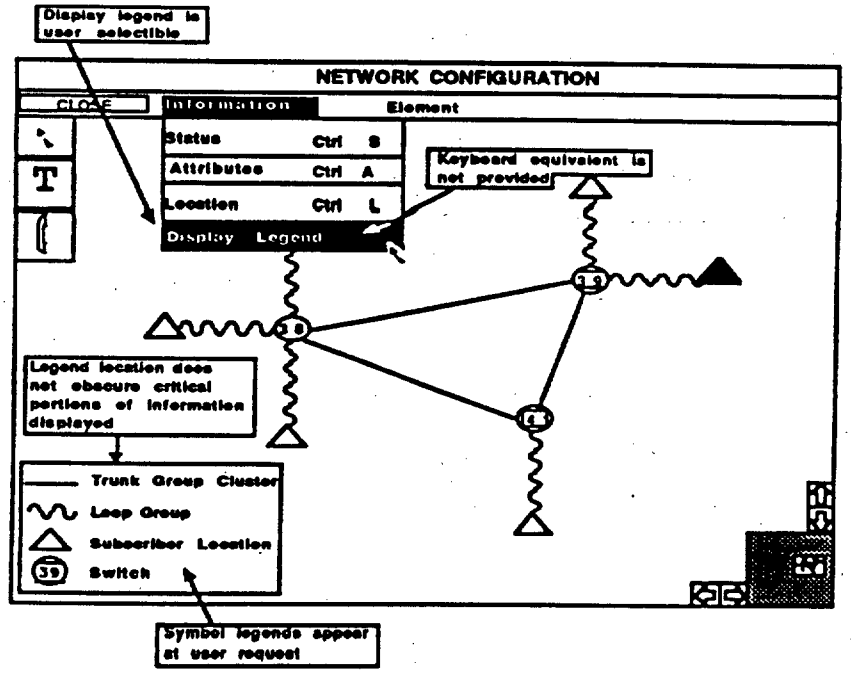

FIGURE 60. Example of highlighted and expanded diagram data.

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5.3.8.7.2 Image control.

a) Where a user must examine an object from different perspectives, the user should be able to rotate the displayed image.

b) When users must analyze pictorial images in detail, computer aids should be provided; (e.g., exploded views, edge/contrast enhancement, overlays).

c) When diagrammed data exceed the capacity of a single display frame and must be shown in separate sections, an overview of the diagram should be provided.

d) A logical linking of a diagrams various sections, and an easy means of movement from one section to another, should be provided (e.g., by panning).

5.3.8.8 Pie charts. A pie chart should be used only to show the relative distribution of data among categories; e.g., for displaying data that represent proportional parts of a whole. Pie charts should not be used when the viewer is to extract quantitative information.

5.3.8.8.1 Format.

a) Partitioning should be limited to five segments or less. Segments should be labeled and numbers provided to their segment labels to indicate the percentage or absolute values represented in the display.

b) When a segment of a pie chart requires emphasis, it should be highlighted by special hatching or shading or by displacing it slightly from the remainder of the pie. See figure 61.

Hypothetical data showing distribution of US Armed Forces in the southern hemisphere

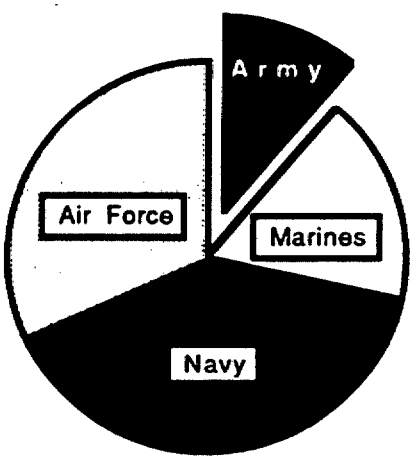

FIGURE 61. Example of a pie chart with segment displacement.

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Data display - Graphics - Pie charts

5.3.8.8.2 Coding/labeling.

a) The chart and each segment should be clearly labeled. If a segment is too small to contain the label, the label should be placed outside the segment with a line from it to the segment.

b) When required, quantitative information should be provided on the chart.

5.3.8.9 Scatterplots.

a) Scatterplots should be used to display correlations among or between variables.

b) Data of particular significance should be highlighted. When scatterplots are grouped in a single display to show relations among several variables, means to highlight selected relations should be provided.

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5.4 Job performance aids.

5.4.1 General. In addition to the guidance which follows, job performance aids display design should also follow the guidance provided in Section 5.4, "Data Display".

5.4.1.1 User control.

a) Standard procedures should be designed for similar, logically related transactions.

b) When techniques adopted for user guidance may slow experienced users, alternative modes should be provided which allows bypassing standard guidance procedures.

c) Explicit actions should be required to access or suppress job performance aids.

d) Users should be able to switch easily between information handling transactions and presentation of guidance material.

5.4.1.2 Format.

a) Display formats should be consistent and readily distinguishable from displayed data.

b) Critical user guidance should be highlighted using the same methods used to highlight critical items in data display.

c) When hierarchic menus are used, they should be organized and labeled to guide users within the hierarchic structure.

d) A standard symbol should be used for prompting entry.

5.4.1.3 Wording and style.

a) Wording should be familiar to the user, oriented to the task, provide guidance directly.

b) Active rather than passive voice should be used in guidance messages.

POOR	BETTER
The user should press ENTER to continue.	Press ENTER to continue.
Do not enter data before clearing the screen.	Clear screen before entering data.
Will you make a selection?	Select one.

FIGURE 62. Examples of wording style.

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Job performance aids - General

c) Messages should be worded concisely, using consistent grammatical structures, phrasing and punctuation. See figures 64 and 65.

d) When transactions occur by a sequence of steps, the same sequence should be used in the wording of user guidance; for example, "SAVE data before QUITTING".

e) Coding abbreviations and wording conventions should follow the display design guidance presented in section 5.3.6, "Text".

5.4.1.4 Speech output.

a) Computer-generated speech output may be used for guidance messages in environments with low ambient noise, when a users attention may not be directed toward a visual display, or when providing a visual display is impractical.

b) Computer-generated speech messages should be limited in number, distinctive from routine messages, short and simple.

5.4.1.5 Performance monitoring. In applications where skilled user performance is critical to system operation, automatic computer recording and assessment of user performance should be provided, in terms of: data accessed, user errors, help requests, user transactions and programs used. Users should be informed of any records kept of individual performance.

5.4.1.6 On-line training. Where possible, on-line training capability should be provided with different levels of training for on-line job support and should adapt automatically to user abilities.

5.4.2 Data display.

5.4.2.1 Help displays.

a) Users should be able to request help and obtain detailed on-line guidance by using standard actions that are always available.

b) Synonyms for standard terminology should be recognized by help routines.

HELP DISK	HELP STORE
HELP FILE	HELP BACKUP
HELP SAVE	HELP ARCHIVE

FIGURE 63. Examples of possible synonyms to access file saving help.

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```
                    TRAINING BALANCE REPORT HELP

        This report displays the balance of funds available within
        your division/office by month for the fiscal year funded.
        Planned courses following todays date and new or approved
        courses, funded only by the Directorate, are displayed in
        order by the course start date.  Planned, estimated and
        actual costs are displayed for each course and totalled
        monthly.  The most up-to-date cost (actual, estimated
        actual, then planned) for each course is subtracted from
        your division's allocation, thus representing your
        division's best estimate of funds available.

        In addition, an audit report listing those courses not
        included in the above report is displayed.  The report
        represents those planned courses whose start date is prior
        to todays date and have no estimated or actual cost.  Those
        courses which have been cancelled are also displayed.

        Following the selection of this report option, the above
        reports will be displayed to the users terminal.

PRESS ENTER TO CONTINUE
4>    JOB
```

FIGURE 63. Example of inconcise wording in a help display.

```
                    TRAINING BALANCE REPORT HELP

        This report displays training funds balance by
        division/office by month by year.

        Order of precedence for funding balance cost estimates are:

                        1. Actual costs, if not available then,
                        2. Estimated costs, if not available then,
                        3. Planned costs


        An audit report follows the training balance report.  Audit reports
        list courses not yet started and/or are not cost estimated or actual.

        Cancelled courses are reported as part of the audit report.


    PRESS ENTER TO CONTINUE
```

FIGURE 65. Example of more concise presentation of help information.

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Job performance aids - Data display

c) Multilevel help should be under user control. Users should be able to browse through on-line help displays.1

d) Help messages should be tailored to task and transaction. Requests for help in ambiguous contexts should initiate a dialog in which the user can specify what data, message or command requires explanation.

e) After requesting help, the user should be provided with easy means to return to the main dialog.

5.4.2.2 Information presented.

a) Specific user guidance information should be available for display at any point in a transaction sequence.

b) Only guidance information relative to transactions of interest should be displayed.

c) During transaction sequences, guidance should be provided telling the user how to continue.

5.4.2.2.1 Status information.

a) Indication of system status should be continuously presented to users. Active operational modes should be clearly indicated to the user.

b) Users should be able to obtain status information concerning current alarm settings, in terms of dimensions (variables) covered and values (categories) established as critical.

c) When interaction is required with other users or systems, information concerning the others status should be provided.

d) Level of system performance should be indicated (e.g., SYSTEM LOAD HEAVY, DELAYS UP TO 30 SECONDS MAY BE EXPECTED).

5.4.2.2.2 Control information.

a) A general list of help control options should be available and should be displayed in logical groups.

b) Where command entry is used, an on-line command index should be available.

c) Control options that are specific to individual help messages should be indicated on the display.

d) Advisory messages or prompts should be provided to guide users in accessing help messages.

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e) Reference material describing system capabilities and procedures should be available for on-line display.

f) Users should not be required to memorize lengthy sequences or to refer to secondary written procedural references to access help messages.

d) Where the user can choose help data to display, an on-line index should be provided.

e) When a user help request depends upon context established by previous entries, an indication of that context should be provided to the user.

f) Users should be able to request a displayed record of past transactions.

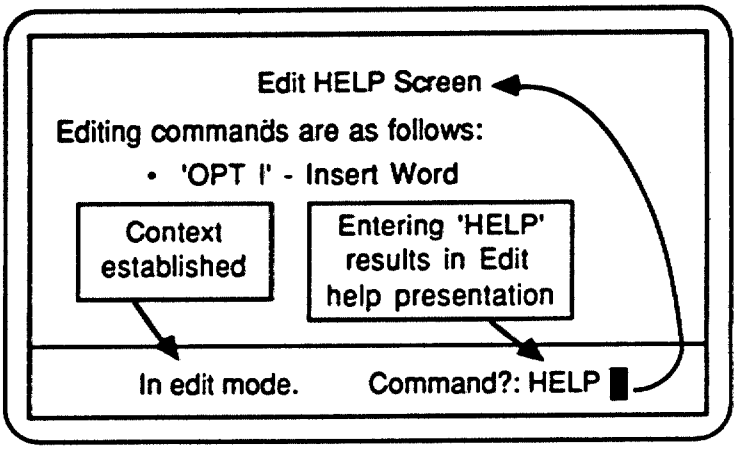

FIGURE 66. Establishment of context in accessing help displays.

5.4.3 Feedback.

5.4.3.1 Routine feedback. Computer response to user entries should be rapid, with consistent timing as appropriate for different types of transactions.

5.4.3.1.1 Information presented.

a) Routine feedback should be provided as transactions are processed and completed.

b) Feedback should be provided for all user interrupts, indicating when the system has returned to a previous or normal status.

c) Indication of transaction status should be provided whenever complete processing will be delayed.

d) When requests for printed output are handled by a remote printer, feedback for print requests should be provided.

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Job performance aids - Feedback

5.4.3.1.2 Format.

a) Displays should be uniquely identified at the top of each display frame.

b) Selected or active options should be displayed automatically or at user request.

c) Items selected to perform operations should be highlighted.

5.4.3.2 Error feedback.

a) Error feedback should be provided if an error or other unexpected event prevents processing and should be displayed within 2 seconds of the entry in which the error is detected.

b) An error message should not be generated as wrong data are keyed, but only after an explicit ENTER action has been taken.

c) To supplement on-line guidance, system documentation should contain a listing and explanation of all error messages.

d) Conditions requiring special user attention should use distinctively coded alarms.

5.4.3.2.1 Information presented.

a) Error information should reflect the user's point of view in terms of what is wrong and what can be done.

b) When multiple errors are detected in merged commands (e.g., SAVE/QIUT/LOG OFF <ENTER>), the user should be notified of each occurrence.

c) When a user repeats an entry error, feedback should be distinguishable from the first occurrence to avoid uncertainty whether the computer has processed the revised entry.

d) Erroneous entries and error messages should be displayed until corrections are made, and should not be displayed after the error has been corrected or is no longer applicable.

e) 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.

f) The user should not have to search through reference material to interpret system messages. However, error messages may refer the user to specific on-line documentation.

g) When possible, users should be able to request more detailed error messages.

5.4.3.2.2 Wording and style.

a) Error messages should be informative, nonthreatening, brief, as specific as possible, and employ neutral wording.

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b) Wording for error messages should be appropriate to a users task.

POOR	'Error ID# 27; file I/O; Device 2'
BETTER	'File TANK.DATA was not found on Disk M60A1-SIMWAM'

FIGURE 67. Example of error feedback.

5.4.3.2.3 Cursor positioning. The cursor should be positioned at the point where an error was detected.

5.4.3.2.4 User response.

a) Users should be required to reenter only the portion of a data/command entry which is not correct and should not have to rekey an entire command string or data.

b) Users should be required to confirm destructive entries before it will be executed by the the computer.

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5.5 Expert systems.

5.5.1 General.

a) Expert system development should be based on: user requirements; preferred dialog types; knowledge engineer requirements; operational requirements; and mental models employed by the human expert and the user.

b) A detailed description of the functional transactions between the system and user should be developed and validated prior to specifying the internal structures of the system.

c) The guidelines for UCI display and control designs included in sections 5.1, 5.3, and 5.4 should also apply to expert system development.

5.5.1.1 Representing causality.

a) To the extent possible, the expert system should be capable of identifying and representing causality between facts contained in its knowledge base.

b) At the request of the user, the expert system should be capable of representing forward causality, in the form of predictions, and backward causality, in the form of speculative reconstruction of events.

5.5.1.2 Specify domains.

a) In selecting knowledge (facts) to be contained in the knowledge base, both a domain model and a set of domain principles should be established.

b) The domain model should contain descriptive causal relationships and classification hierarchies, including: failure modes, conditions and effects; symptoms; measures/estimates of criticality/priority; and, alternative responses (including effects/constraints).

c) The set of domain principles should contain prescriptive methods and heuristics, including: hypotheses to be developed; data to be acquired; tests to be conducted; and, decisions to be made.

5.5.2 Dialog.

a) The system should support a flexible dialog that permits either the user or the expert system to initiate an action or request for information, without cancelling an ongoing transaction.

b) The user-expert system dialog should be flexible in terms of the type and sequencing of user input it will accept.

c) When inexperienced users are required to interact with the expert system, menu, form filling, query or question/answer dialog modes are preferred over command language dialog modes.

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Expert systems - Dialog

d) The system should be designed to permit rapid retrieval of previous exchanges between the user and the expert system for the current transaction. The preferred method for such retrieval is scrolling.

e) User-expert system information exchange should be based on: the range of data types which will be input by the user (text, numeric, graphic); the extent and frequency of each data type entry; how user-generated data be acquired (e.g. , volunteered by the user at the start of a consultation, elicited by the expert system on an as-needed basis, etc.); the range of data types which will be output by the expert system (text, numeric, graphic); the extent and frequency of each data type output; and pacing of user queries.

f) For the mode of expert system dialog selected (natural language, etc), the appropriate guidelines of section 5.2, "Dialog/Interaction Control", should also apply to expert systems dialog design.

5.5.3 Problem statement/input.

5.5.3.1 Problem definition and consultation planning.

a) The expert system should provide the capability for the user to plan a strategy for addressing a problem. This plan may include data to be acquired, hypotheses to be tested, criteria for accepting/rejecting hypotheses, etc.

b) The capability provided by the expert system should include: planning aids (such as time lines, worksheets); an evaluation function which assesses the adequacy of the user's plan and recommends revisions where necessary; the ability to form, state and test hypotheses in a manner consistent with the user's plan; and, the capacity to store and recall plans.

5.5.3.2 Consultation.

a) The expert system should be capable of supporting a complete range of problem solving strategies, including: reliability (i.e., failure rate); conditional probability; syndrome/symptom analysis; signal tracing; half-split; and, bracketing. The expert system should be capable of accepting direction from the user in terms of which strategy to employ.

b) The control strategy should support both forward (data-driven) and backward (goal-driven) chaining to allow the user or expert system to provide data or propose a new or revised goal, as appropriate, for the transaction underway.

c) The system should be capable of supporting speculative analysis (e.g. , what-if scenarios) by providing a "reconnoiter mode" that allows the user to investigate the effects of an action without actually implementing the action.

d) Entering a reconnoiter mode should require an explicit command by the user and should result in a clearly distinguishable change in system output (e.g., a blinking reconnoiter mode symbol) to ensure that the user is apprised of the change in operating mode.

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Expert systems - Problem statement/input

e) The expert system should be capable of providing interactive explanations using the facts and rules contained in its knowledge base.

What would happen if. . . ?
Are there significant side effects to. . . ?
How do x and y interact?
What causes x?
What are the results (effects) of x?
Given x, how should I respond?

FIGURE 68. Types of questions expert systems should be capable of handling.

f) The knowledge required to perform all functions allocated to the expert system should be directly accessible by the expert system.

g) Requirements for the expert system to query the user to obtain information for routine functions should be minimized.

h) The capability for the user to supercede the current request for information from the expert system in order to input information related to a different transaction should be provided.

i) The user should not have to complete all elements (e.g., fields) of an expert system requested form in order to complete a phase of a transaction.

5.5.4 Display.

5.5.4.1 Dynamic information.

a) With the exception of mission-critical information, display of dynamic information should "freeze" during extended explanation sessions to ensure that a significant change in status does not escape notice by the user.

b) At the completion of the explanation session, the system should update and highlight any changes in displayed values, and request acknowledgment by the user.

c) If mission-critical information becomes available during an extended explanation session, the system should alert the user, via prompts or other alarm mechanisms, and immediately display the information to the user.

5.5.4.2 Graphics interface.

a) The expert system should have the capability to graphically represent its rules network. This capability should be available to the user as an adjunct to the explanation subsystem.

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Expert systems - Display - graphics interfaces

b) Graphics, such as a system schematic, should be used to depict relationships between system configuration and measurable parameters.

c) To the extent possible, graphics should portray system/component/process status through the use of color, shading, or similar coding techniques.

d) Coding techniques should be consistently applied across the expert system.

e) The guideline of Sections 5.2.8 "Iconic Interaction", 5.3.6 "Graphics Entry", and 5.3.8 "Graphics [display]" should apply to expert systems graphic interfaces.

5.5.4.3 Off-line printing.

a) The expert system should have access to an off-line printer to allow the user to request hardcopy of screen displays (text or graphics), summaries of extended consultations, lists of rules/facts invoked during a consultation, and summaries of hypotheses tested and data employed during a consultation.

b) The printer may be used as an alternative display device to free up the primary workstation.

5.5.5 Certainty factors.

5.5.5.1 Weighting certainty factors.

a) If weighting is appropriate, certainty factors should reflect a weighted combination of probabilistic cost - benefit judgements.

b) If numerical representation is used, certainty factors should reflect the criticality of a conclusion with regard to achieving mission success).

c) The rationale underlying the weighting should be explicitly encoded.

5.5.5.2 Representing certainty factors.

a) The rule set for an expert system should be capable of representing certainty factors to the user. Certainty factors may be contained in the data, in one or more rules, or both.

b) Certainty factors should be represented as a decimal number from -1 to +1, with -1 indicating absolute certainty that a fact is not true, and +1 indicating absolute certainty that a fact is true.

c) Certainty factors displayed to the user should reflect the cumulative certainty for all elements of the conclusion being drawn.

Expert systems - Explanation facilities

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d) In addition to numerical values of certainty, the system should be capable of providing some indication of rationale underlying the uncertainty, such as conditions when the rule was invalid.

5.5.6 Explanation facilities.

a) The expert system should be capable of explaining its behavior, problem solutions, and knowledge.

b) At any point during a consultation, the expert system should be capable of displaying the rule currently being invoked.

c) The expert system should automatically record all rules invoked during a consultation.

d) Following a consultation, the explanation facility should be capable of recalling each invoked rule and associating it with a specific event (i.e. , question or conclusion) to explain the rationale for the event.

e) The explanation facility should be able to search the knowledge base to locate rules or items of knowledge in response to specific inquiries from the user, to alert the user when a problem is beyond its current capabilities, and instruct the user as to what additional knowledge or rules would be required to complete the transaction.

f) The expert system should be able to respond to user requests to clarify or restate questions and assertions.

g) The system should be capable of displaying both rule-based and descriptive explanations, as requested by the user.

h) At any point during a transaction, the expert system should be able to explain which problem solving strategy is being employed, why a particular strategy was selected, and the current status of the application.

5.5.6.1 Language/style.

a) The presentation of information to explain or justify the behavior or knowledge of the expert system should be consistent in content and format with the cognitive strategies and mental models employed by the user, particularly when the user and the expert system are independently working the same problem.

b) At a minimum, the explanation facility should employ the same nomenclature, abbreviations and acronyms for system elements as those employed by the user.

c) The system should be capable of emulating a degree of "self-awareness" by portraying, via the explanation facility, the knowledge it contains concerning the application, relevance and validity of rules and knowledge (facts) contained in its knowledge base.

Expert systems - Explanation facilities

d) Explanation facility knowledge should include an understanding of the strategies and

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processes by which rules and facts are applied.

e) The guidelines of Section 5.3.6 "Text [display]" should be applied to explanation facilities design.

5.5.6.2 Strategy explantion. At any point during a transaction, the expert system should be able to explain which problem solving strategy is being employed, why a particular strategy was selected, and the current status of the application.

5.5.6.3 Relation to rules and knowledge base.

a) Rules should be represented explicitly in the knowledge base and encoded in such a manner that it is accessible to the explanation facility and can be translated for human understanding.

b) The content and detail of a rule's explanation/justification should be consistent with the classification of the rule.

c) For most systems, rules may be assigned to one of the following classes:

1) identification rules (rules based on the properties of a class)
2) causal rules (rules whose premise, action, or conclusion are related by a causal argument
3) world fact rules (rules that are based on empirical, common sense knowledge about the world)
4) domain fact rules (rules that link hypotheses on the basis of domain definitions).

d) Rule exceptions should be explicitly contained in the knowledge base and should be available to the user as part of the explanation facility.

e) The explanation facility should have access to the rationale by which the hypotheses in a rule's premise were ordered.

f) The rationale for ordering hypotheses should be explicitly represented for the following classes of hypotheses:

1) hypotheses related to personnel health and safety
2) hypotheses related to mission success, mission-critical equipment or mission-critical data
3) hypotheses related to nonmission-critical equipment or data
4) hypotheses related to mission efficiency and economics.

5.5.6.4 Levels of explanation.

a) The level of detail of information presented as part of an explanation or justification should be under the control of the user.

b) The user should be able to specify three levels of detail: rules only, brief explanations

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and detailed explanations.

c) Control of the explanation facility should be designed such that the user may specify the level of detail as a default option at the beginning of a transaction.

d) For any individual explanation, the user should be able to request greater or lesser detail.

e) Systems employing means-ends analysis as an element of the control strategy should provide:

1) a description of the current state
2) a description of the goal state
3) a description of the difference between the current state and the goal state
4) descriptions of all candidate operators (rules), including the type and amount of difference they eliminate
5) a description of the strategies for transforming the current state or revising the goal state.

5.5.6.5 Representing reasoning. When representing its reasoning process to the user, the expert system should be capable of describing how well the observed data support each hypothesis under consideration and how well each hypothesis under consideration account for the observed data.

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5.6 Data communication.

5.6.1 General.

5.6.1.1 User control/procedures.

a) Data transmission functions should be integrated with other information handling functions within a system.

b) Procedures for preparing, sending and receiving messages should be consistent between transactions and other information handling tasks.

c) Data transmission procedures should be designed to minimize memory load on the user and to minimize required user actions.

d) Both sending and receiving messages should be accomplished by explicit user action.

e) Users should be provided flexible control of data transmission, in terms of what, when and where data should be transmitted.

f) Users should be able to interrupt message preparation, review, or disposition, and resumption should be from the point of interruption.

5.6.1.2 Wording and message content.

a) Functional task oriented wording should be used for terms in data transmission.

b) Transmitted data should be annotated with any alarm/alert conditions, priority indicators, or other significant information.

5.6.2 Message preparation.

5.6.2.1 Procedures. Procedures for composing messages should follow the general data entry and editing procedures presented in Section 5.3 "Data Entry" of this handbook. Users should not have to learn procedures for entering message data that are different from general data entry.

5.6.2.2 User control.

a) Users should be provided means to specify data to be transmitted and should be able to incorporate existing file data (including other messages received or transmitted) in messages.

b) Users should be able to prepare and transmit messages of any length.

c) Users should be able to save draft messages during preparation, or upon completion.

d) When messages must be transmitted following data change, the user should confirm that the data are ready to be transmitted.

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Data communication - Message preparation

5.6.2.3 Format.

a) Unless a need exists for a specific message format (encryption, order of data analysis, etc), users should be able to compose and transmit messages with a format of their own design, and to compose and transmit messages as unformatted text.

b) When messages must conform to defined formats and standards, preformatted forms should be available to users.

c) Where possible, the system should provide automatic message/text formatting for optional use.

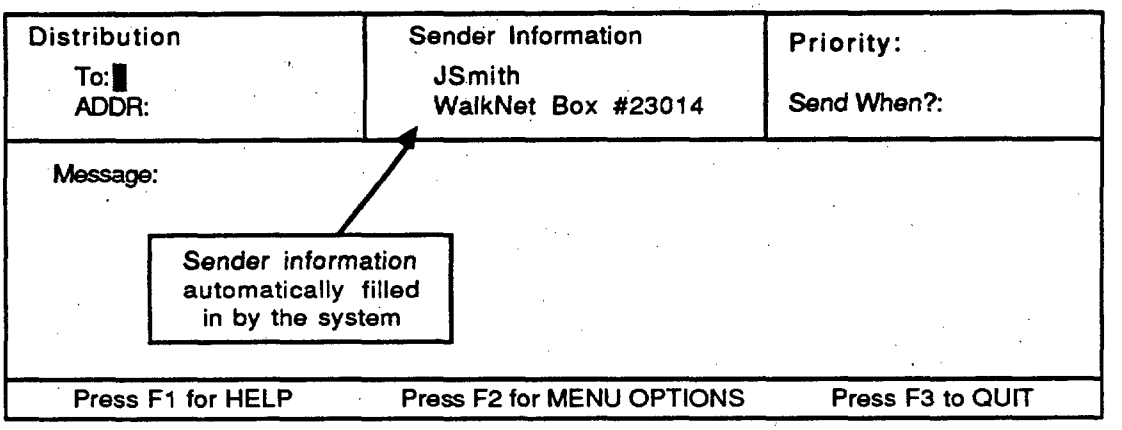

FIGURE 69. Example of a preformatted message preparation form.

d) In forms preparation for transmission, users should be able to enter, review, and edit data on any display organized with labeled fields.

e) Users should be able to enter, review, and change tabular or graphic data in customary formats; e.g., row/columns.

5.6.3 Data transmission.

5.6.3.1 Addressing messages.

5.6.3.1.1 User control.

a) Users should be able to specify destinations where data will be transmitted by system users (as individuals or groups), other work stations, terminals (including remote printers), or users of other systems.

b) Users should be able to edit the address fields in the header of a message being prepared for transmission.

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5.6.3.1.2 Format.

a) A basic set of header fields (DATE, TO, FROM, COPIES, TIME, etc. that can be interpreted by all systems to which messages will be sent) should be provided.

b) Prompting should be used to guide the user in specifying the address for a message.

c) The address of a recipient should occur only once in a message.

5.6.3.1.3 Directories/distribution lists.

a) Address directories should be provided in which users are able to search address directories by specifying a complete or partial name, or other address information and are able to select addresses without reentering the information.

b) Users should be able to define names for commonly used addresses, to save those in a file, and to address messages by name.

c) Users should be provided with information about distribution lists on which they are included, and lists they are authorized to use.

c) Users should be able to create and modify their own lists, and within a distribution list, users should be able to include other distribution lists as well as individual addresses.

d) Where coordinated review of messages by several recipients is required, the sender should be able to specify a serial distribution so that a message will be passed from one recipient to the next.

5.6.3.1.4 Validation and error correction.

a) Computer checks for address accuracy should be provided (i.e., recognized content and format).

b) Users should be required to correct mistakes before initiating message transmission.

c) Users should be able to print copies of transmitted messages.

5.6.3.2 Initiating transmission.

5.6.3.2.1 System control.

a) When standard messages must be transmitted (as when a computer is monitoring external events and reporting data change) means should be provided to initiate transmission automatically.

b) Automatic queuing of outgoing message should be provided to reduce user involvement in routine transmission.

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Data communication - Data transmission - Initiating transmission

5.6.3.2.2 User control.

a) Users should be able to initiate data transmission directly, by entering an explicit SEND command.

b) Users should be able to choose whether to transmit a displayed version of a message, or to transmit directly from stored files.

c) Users should be able to assign priority to messages, and to defer the transmission of messages to a specific date, time, or by later action.

d) Message transmission should be provided with annotations such as "RECEIPT REPLY REQUESTED", under sender's control.

e) Senders should be able to cancel or abort a transmission that has not been completed or initiated.

5.6.3.2.3 Data display.

a) Status information concerning the identity of other system users currently on-line should be available.

b) When a message is sent, the computer should append the sender's address, and the date and time of message creation and transmission.

5.6.3.3 Controlling transmission.

5.6.3.3.1 System control.

a) Transmitted data should be protected automatically with parity checks to detect and correct any errors that may occur.

b) Automatic feedback should be provided for data transmission, confirming that messages have been sent, or indicating transmission failures.

c) Only one copy of any message should be transmitted to an individual addressee.

5.6.3.3.2 User control.

a) Users should be able to specify what feedback will be provided for message transmission, and to request specific feedback for particular messages.

b) Users should be able to recall or abort transmissions after initiation, if messages have not been received.

c) When required, automatic record (LOG) keeping should be provided.

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5.6.3.4 Transmission failure.

a) In the event of transmission failure, automatic queuing should be provided to preserve outgoing messages.

b) If message transmission fails, automatic storage of undelivered messages should be provided, and the sender should be notified. Notification should, if possible, include an explanation of the failure.

5.6.4 Message receipt.

5.6.4.1 System control.

a) Incoming messages should be automatically queued by time of receipt, message priority, or user specification, pending subsequent review and disposition by the user.

b) Logs of messages received and sent should be automatically maintained by the system.

5.6.4.2 User control.

a) Users should be able to specify data that may be received, by specifying receipt priority or other means, and should be able to choose what device (files, display, printer) will receive messages.

b) Users should be able to specify "filters" based on message source, priority, type, or content, that will control notification for incoming messages.

c) Users should be able to assign their own names and other descriptors to received messages.

d) Users should be able to discard unwanted messages without filing.

5.6.4.3 User review of messages.

a) Means should be provided for users to specify message summary listing orders.

b) Unless required for security or other procedure, means for review of messages (in their incoming queue) should be provided without requiring user disposition (e.g., saving, deleting, responding, etc.).

c) Users should be able to review summary information about the type, source, and priority of queued incoming messages.

d) Display designs for received messages should be consistent with general data display guidelines presented in Section 5.3.6 "Data Display - Text". For example, in terms of means provided to scroll through text, saving messages as a file, etc.

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Data communication - Message receipt

e) Users should be able to annotate reviewed messages. Annotations should be displayed and should be distinct from the message itself.

f) An indication of message size should be included in message summaries and at the beginning of each incoming message.

5.6.4.4 Format.

a) If data transmission arrives in an incompatible format (with system decoding or device capabilities), recipients should be advised.

b) Incompatible formats should not destroy the incoming message or any ongoing transactions of the receiver.

5.6.4.5 Data display.

a) Users should be notified at log-on of any data transmissions received since last use of the system.

b) Notification of arriving messages should not interfere with a users ongoing tasks.

c) Priority of received messages should be indicated in applications where incoming messages will have different degrees of urgency, i.e., different implications for action.

5.6.4.6 Reply. When replying to a message, the appropriate address(es) should be provided automatically.

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5.7 Data protection.

5.7.1 General.

a) Clear and consistent procedures should be provided for different types of transactions, particularly those involving data entry, change, deletion, and error correction.

b) Where possible, the system should deal appropriately with user errors and random inputs, without introducing unwanted data change.

5.7.1.1 System control.

a) Automatic measures to minimize data loss from computer failure should be provided.

b) Whenever possible, automated measures for data security should be provided, relying on computer capabilities rather than on humans.

c) When a proposed user action will interrupt a current transaction sequence, automatic means to prevent data loss should be provided.

d) Where potential data loss cannot be prevented, the user should be warned, and the action should not be implemented without user confirmation.

```
LOGOFF

   The file 'MESSAGE.TEXT' has not been saved.
      SAVE 'MESSAGE.TEXT'? (Y or N): Y

SAVING 'MESSAGE.TEXT'

LOGOFF
```

FIGURE 70. Example of a log-off warning to prevent data loss.

e) When function keys or other devices are not needed for a transaction type and when they may have destructive effects, they should be disabled under software control to avoid activation.

f) Automatic defaults, if provided for control entries, should protect against data loss, and should not contribute to the risk of data loss.

5.7.1.2 User actions.

a) Data should be protected from inadvertent loss caused by the actions of other users. Users should be able to designate their own files and data as protected from the actions or access of others.

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Data protection - General

b) Frequent or urgent actions should be easy to perform, potentially destructive actions should be sufficiently difficult to require additional user attention.

b) Unless real-time computer monitoring is performed, data should be changed only as a result of explicit user actions.

c) Explicit action to select destructive modes should be required.

d) Users should be required to take an explicit extra action to CONFIRM a potentially destructive or critical control entry before it is accepted by the computer for execution.

e) A CONFIRM action should be distinctively labeled.

f) Users should be required to wait for computer prompting to CONFIRM so that the confirmation will constitute a second, separate action.

```
TRANSMIT

    The transmission 'READINESS REPORT' has not been encrypted
          ENCRYPT 'READINESS REPORT'? (Y or N):  N

                    **Please  CONFIRM **

    The transmission 'READINESS REPORT.' should be encrypted.
          ENCRYPT then TRANSMIT?  (Y or N):  Y

ENCRYPTING . . .

Message  'READINESS REPORT' off at  1423  hours  on  25:4:87

Enter command: ▌
```

FIGURE 71. Example confirming action prior to command execution.

g) Users should be able to UNDO an immediately preceding control action that may have caused an unintended data loss.

h) Users should not be able to change (delete, edit, etc.) protected or controlled data.

5.7.1.3 Simulation and training.

a) When simulated data are used in conjunction with system functions (e.g., during training or operability tests), actual, unsimulated data should be protected.

b) Operational system use should be clearly indicated and distinguishable from simulated operations.

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5.7.1.4 Data display.

a) Computer logic that will generate messages or alarm signals should be provided to warn users (and system administrators) of potential threats to data security, (i.e., of attempted intrusion by unauthorized persons).

b) A continuous indication of the current operational mode (data entry, edit, etc.) should be displayed, particularly when transactions might result in data loss.

c) For conditions which may require special user attention to protect against data loss, an explicit alarm or warning message should be provided to prompt appropriate user action.

5.7.2 User authentication.

5.7.2.1 Unauthorized access. A limit on the number and rate of unsuccessful LOG-ON attempts should be imposed to provide a margin for user error, while protecting the system from persistent attempts at illegitimate access.

5.7.2.2 Identification and passwords.

a) LOG-ON processes should be designed to provide prompts for all user entries, including passwords and other data required to confirm user identity and to authorize data access privileges.

b) When system security requires more stringent user identification than is provided by password entry, auxiliary tests may be used that authenticate user identity, but should not impose impractical demands on users memory.

c) Users should be able to choose or change their own passwords.

d) Where data protection is critical, user selected passwords should be tested against a list of common passwords ("me", "66 Vette", "ABC", etc.) or commonly known user data (such as names spelled backwards "ydnA", users birth dates, etc.).

e) When a password must be entered by a user, password entry should be private; password entries should not be displayed, but display echoes (such as "*") for each keystroke should be provided.

f) Unless a specified period of inactivity has expired or under special security procedures, whatever data access/change privileges are authorized after identity, authentication should continue throughout a work session.

5.7.3 Data access.

5.7.3.1 Classified data protection.

a) When displayed data are classified for security purposes, a prominent indication of security classification should be presented in each display.

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b) When classified information is displayed, some rapid means for suppressing a display should be provided.

c) Procedures to control access to printed or printing data should be provided rather than prohibiting the printing of classified information.

d) When sensitive data may be exposed to unauthorized access, a capability for encrypting data should be provided. Data encryption should be easily reversible.

5.7.3.2 Record/log keeping.

a) The computer should automatically keep records/logs of data access.

b) Users should not be relied on to take critical record keeping actions.

c) Transaction records and logs should be stamped with user identifiers, time, and date. Provisions should be made to control requests for records and logs of data transactions with classified material.

d) Users should be informed concerning the nature and purpose of automated recording of individual actions.

e) When multiple users review, enter, or modify data in a system, they should be able to review and browse data changes or entries made by other users.

5.7.3.3 Data preservation.

a) When protection of displayed data is essential, the computer should maintain control over the display and should not permit a user to change "read-only" data.

b) A "read-only" status should be indicated for users not authorized to change displayed data.

c) Provisions should be made to prevent accidental activation of potentially destructive control actions.

d) When required, display formatting features, such as field labels and delimiters, should be protected from change by users.

e) If a complete file is to be deleted, sufficient information, (name, description, size, date established, date last changed, etc.) should be displayed to verify the file for deletion.

f) Users should be required to confirm destructive entries.

g) The prompt for a CONFIRM action should warn users explicitly of any possible data loss.

h) An explicitly labeled CONFIRM function key, different from the ENTER key should be

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provided for user confirmation of critical control and data entries.

POOR	CONFIRM DELETE
BETTER	CONFIRM deletion of entire 'AIRFIELD' file??

FIGURE 72. Example prompts for a CONFIRM action.

i) Data loss at LOG-OFF should be avoided by a check on pending transactions and display of an advisory message requesting user confirmation.

j) When two or more users have simultaneous read access or data processing results from multiple user-computer interfaces, the operation by one person should not interfere with the operations of another person, unless mission survival may be contingent upon the preemption.

k) Provisions should be made so that the preempted user can resume operations at the point of interference, without information loss.

5.7.3.4 Data entry/change. Procedures for data entry and change should follow guidelines presented in Sections 5.3 "Data Entry", 5.2 "Dialogs/Interaction Control, and 5.4 "Data Display".

5.7.4 Classified data transmission.

5.7.4.1 System control.

a) Measures provided to protect data during transmission (e.g., encryption, parity checks, buffering until acknowledgment of receipt) should be applied automatically, without the need for user action.

b) A copy of any transmitted message should automatically be saved until correct receipt has been confirmed.

c) As necessary, automatic queuing of incoming messages should be provided to ensure they do not disrupt current classified information handling tasks.

5.7.4.2 User actions.

a) When a user must confirm the identity of a message source, computer aids such as computer-generated confirmation codes should be provided for that purpose.

b) When human judgment may be required to determine whether data are appropriate for transmission, users or a system administrator should be provided means to review outgoing messages and confirm release before transmission.

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6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory).

6.1 Intended use. This handbook is intended for use as design guidelines for analysis, design, and evaluation of computer based Management Information Systems. It is not intended for use to express binding requirements in conceptual and other early acquisition phases. The handbook may be applied to traditional, as well as non-developmental items (NDI) acquisitions.

6.2 Issue of DODISS. When this handbook is used in acquisition, the applicable issue of the DODISS must be cited in the solicitation (see 2.1.1 and 2.2).

6.3 Subject term (key word) listing.

Data Communication
Data Entry
Data Protection
Design
Dialog/Interactive Control
Display
Expert Systems
Human Engineering Guidelines
Job Performance Aids
Management Information Systems
User-computer Interface

6.4 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue date due to the extensiveness of the changes.

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Appendix A

Checklists

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Checklist	YES	NO	N/A
5 Detailed guidelines.			
5.1 Dialog/interactive control.			
5.1.1 General.			
a) The user has the initiative in transaction control, and system control is subordinate to user control.			
b) Users provide the pace of transaction sequences.			
c) Transaction control is by explicit user action.			
d) Control by simultaneous users do not interfere with those of other users.			
e) Transaction options areprovided which match expected user goals and tasks.			
5.1.1.1 Log-on.			
a) When users must log-on to a system, log-on is a separate procedure that is completed before a user may select any operational options.			
b) The log-on frame appears as soon as possible on the display with no additional user involvement.			
c) Log-on delays are accompanied by an advisory message to tell the user status and when the system will become available.			
d) Knowledge of the internal mechanisms and other technical aspects of the system is not be required of the user to log-on or otherwise use the system.			
e) Average system response time, if affected by the number of on-line users, is displayed at time of log-on. This message is not in code but contains specific information concerning current response time and the periods when response time is relatively quick.			
f) After completing the log-on process, the user is able to start productive work immediately.			

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Checklist	YES	NO	N/A
5.1.1.2 Log-off. a) If there are pending actions and the user requests a log-off, the system informs the user that these actions will be lost. b) Interactive timesharing systems allow time, between keyboard actions before automatic log-off, unless a longer period is requested by the user. c) An audible signal is presented at specified intervals prior to automatic log-off. d) Where possible, open files are saved to some defined file name. 5.1.1.3 Simplicity. a) Transaction control is simple, flexible, adaptive, consistent, minimize user actions, compatible with the lowest anticipated user skill level, and are logical in terms of user task sequences and functions. b) Users are able to predict system responses to their actions. c) Transaction control is consistent in form and consequences and employ similar means to accomplish similar ends. d) When hierarchical levels are used to control a process or sequence, the number of levels is minimized. e) Display and input formats are similar within levels and the system indicates current positions within a sequence. 5.1.1.4 Transaction selection. 5.1.1.4.1 Timing and pacing. a) Users are able to select transactions; computer processing constraints do not dictate transaction control. b) When appropriate to task requirements, users are able to specify transaction timing. 5.1.1.4.2 Options list/prompting. a) A general list of basic control options is available to serve as a "home base" or consistent starting point for control entries.			

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Checklist	YES	NO	N/A
b) A general options list presents options grouped, labeled and ordered in terms of their logical function, frequency, and criticality of use.			
c) A list of the control options that are specifically appropriate for any transaction is displayed by listing in the working display or by user command.			
d) Information that the user needs to perform transactions is displayed without burdening short and long term memory.			
e) Transactions never leave the user without further available action.			
f) Transactions provide next steps or alternatives.			
g) Control entry prompting is provided.			
5.1.1.4.3 Command selection.			
a) Task oriented wording for control options is used to reflect the users view of the current transaction.			
b) Only available transaction options are offered to users and control defaults are indicated.			
c) A consistent control option to continue to the next transaction is provided.			
d) User interrupt or abort functions to terminate transactions is provided.			
e) The requirement to learn mnemonics, codes, special or long sequences, and special instructions is minimized.			
5.1.1.4.4 Merging commands.			
a) Users are able to key a sequence of commands or option codes as a single control entry.			
b) Users are able to assign a name and use that named "macro" for subsequent command entry.			
c) For control entry merging, command names, abbreviations, or option codes are accepted as if those control entries had been made separately.			

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Checklist	YES	NO	N/A
d) Required punctuation of merged entries is minimized. A standard delimiter in separating commands is used; e.g., a slash (/).			
5.1.1.5 Context definition.			
a) Transaction context is provided for the user.			
b) Unless contextual interpretation of commands would have destructive effects, transaction control software interpret currents control actions in the context of previous entries without requiring users to reenter data.			
c) Users are able to request a summary of the results of prior transactions to determine present status.			
d) When context for transaction control is established in terms of a defined operational mode, the operational mode is displayed.			
e) Users are able to review control parameters that are currently operative.			
f) If the consequences of a control entry will differ depending upon context established by a prior action, a continuous indication of current context is displayed.			
g) When performing an operation on a selected item, the item is highlighted.			
h) Information displayed to provide context for transaction control is distinctive in location and format, and consistently displayed from one transaction to the next.			
i) Displayed options, command entry areas, prompts, advisory messages, and other displayed items relevant to transaction control is distinctive in position and format.			
j) Formats are consistent from one frame to the next.			
5.1.1.6 Abbreviations and acronyms.			
a) Where possible, use of abbreviations and acronyms is avoided.			
b)Where not possible, standard abbreviations, acronyms, and display codes conform to MIL-STD-12, MIL-STD-411, or MIL-STD-783.			

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Checklist	YES	NO	N/A
c) New acronyms, if required, are developed according to the rules of MIL-STD-12. Extent of deviation from abbreviation rules is minimized.			
d) Abbreviations, mnemonics, and acronyms do not include punctuation.			
e) When abbreviations are used, a dictionary of abbreviations is provided to the user.			
f) Abbreviations are unique, distinct and unambiguous.			
g) Using abbreviations does not confuse the user or add to system operation time.			
5.1.1.7 Labeling and terminology.			
a) Consistent terminology for transaction control is adopted.			
b) Congruent names for control functions is adopted.			
c) Transaction wording is consistent with user guidance and frame of reference.			
d) For interpreting user-composed control entries, upper and lower case letters are treated as equivalent.			
e) The length of individual input words does not exceed seven characters.			
5.1.1.8 Prompting/structuring.			
a) The system contains prompting and structuring features designed to: prompt for all required input parameters; request additional or corrected information from the user; provide orientation to the user during transactions; and indicate when errors have been detected.			
b) Prompts inform the user what information is to be input.			
c) Where six or fewer control options exist, they are listed.			
d) Where more input options exist, an example of the type of entry that is required is presented.			
e) The system prompts for all required input parameters. The			

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Checklist	YES	NO	N/A
level of prompting detail is controllable by the user.			
f) Prompting messages appear at a standard location on the screen.			
5.1.1.9 System messages.			
a) Message language is distinct, meaningful, and easily discriminated.			
b) Humorous or sarcastic messages are avoided.			
c) Messages make the user feel in control.			
d) Messages do not present the system as a person.			
e) When a message appears on the screen, both the content of the message and the action required by the user is explicit.			
f) Messages detailing the users status is displayed.			
5.1.1.10 Feedback.			
a) Positive feedback is provided for all control entries.			
b) Completion of transaction processing is indicated by feed back messages.			
c) When system functioning requires the user to standby, periodic feedback is provided to indicate normal system operation.			
d) Successive periodic feedback messages differ in wording from presentation to presentation, or are otherwise indicated.			
5.1.1.11 Alarms.			
a) Where alarm conditions are not predefined by functional, procedural, or legal requirements, users are able to define the conditions that will result in computer generation of alarm messages.			
b) Alarms are distinctive and consistent.			
c) Users are provided with a simple means of acknowledging and turning off noncritical alarm signals without erasing any displayed message that accompanies the signal.			

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Checklist	YES	NO	N/A
d) If users are required to acknowledge a special or critical alarm in some special way, acknowledgment does not inhibit or slow user response to the alarmed condition.			
5.1.1.12 System response time.			
a) Computer response time to user entries is appropriate to time constraints imposed by the task or mission, specific data processing applications, and type of transaction.			
b) The guidelines of Table 1 are used as guidance for maximally acceptable system response time.			

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Checklist		YES	NO	N/A
System Interpretation	Response Time Definition		Acceptable Response Time (Seconds)	
Key Response	From key depression until positive response; e.g., "click" or display echo		0.1	
Key Print (echo)	From key depression until appearance of character		0.2	
Page Turn	From end of request until first few lines are visible		1.0	
Page Scan	From end of request until text begins to scroll		0.5	
Data Field Entry	From selection of field until visual verification		0.2	
Function Selection	From selection of command until response		2.0	
Pointing	From input of point to display of point or pointing device		0.2	
Drawing/ Sketching	From input of point to display of point, line, arc, etc.		0.2	
Local Update	Change to image/display using local data base, e.g., new menu list display		0.5	
Host Update	Change where data is at host in a readily accessible form, e.g., a display scale change		2.0	
File Update	Image/display update requiring access to a host file		10.0	
Simple Inquiry	From command until display of a common message		2.0	
Complex Inquiry	Response message which requires seldom used calculations in graphic form		10.0	
Error Feedback	From entry of input until error message appears		2.0	

Table 1.
Acceptible System Response Times.

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Checklist	YES	NO	N/A
c) Temporary keyboard/device lockout due to processing of transaction control entries is minimized, and does not exceed 0.2 seconds. d) Where control entries must be delayed pending computer processing of prior entries, then control entry is acknowledged. e) When display generation is slow, the user is notified as display output is complete. f) Control response time variability is within the limits below:			

Control Response Time		Variability
0 to 2 seconds	-	less than 5%
2 to 5 seconds	-	less than10%
greater than 5 seconds	-	less than15%

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Checklist	YES	NO	N/A
5.1.1.13 Dialog type selection. a) Dialog type matches task requirements and user abilities. b) Question and answer dialog may be used for routine data entry tasks, where data is known and ordering can be constrained, for users with little or no training, and where computer response is expected to be moderately fast. c) Form filling dialog may be used where flexibility in data entry is needed, where users are moderately trained, where computer response may be slow, and as an aid for composing complex control entries. d) Menu selection dialog may be used for tasks that involve choice among a constrained set of alternatives, where little entry of arbitrary data is required, where users have little training, when a command set is too large to commit to user memory, and where computer response is relatively fast. e) Function keys may be used in conjunction with other dialog types for tasks requiring a limited number of control entries, as an immediate means to accomplish frequent or control transactions, or for criteria control entries. f) Command language dialog may be used for tasks involving a wide range of control entries, where users are highly trained or will use the system frequently, and for tasks where control entries may be mixed with data entries in arbitrary sequence. g) Query language dialog may be used for tasks emphasizing unpredictable information retrieval with moderately trained users. h) Constrained natural language dialog may be used in applications where task requirements are broad ranging or poorly defined, and where little user training can be provided.			

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Checklist	YES	NO	N/A
5.1.2 Question and answer dialog. a) Questions are displayed separately, posing of compound questions is avoided. b) When computer posed questions are interrelated, answers to previous questions are displayed; users are not required to remember prior answers to provide context for current questions. c) As appropriate, question sequence is compatible with source documents. 5.1.3 Form filling dialog. In addition to the guidelines contained here, the guidelines of section 5.2, "Data Entry", and Section 5.2.4, "Form Entry", are applied to the design of form filling dialogs. a) As appropriate, defaults for control entry in form filling are provided. b) Control forms and formats are presented in a consistent and logical format. 5.1.4 Menu selection dialog. a) Each related group of menu options permit only one selection by the user. b) Where multiple options can be selected, they are identified, by label or by option coding. c) All available options are explicitly and completely displayed for a selected menu. d) Users are able to distinguish between available and unavailable options. e) Unavailable menu options are displayed along with available options. f) An input prompt clearly indicates to the user that the computer is waiting for a response and a standard symbol is used for prompting entry. g) Feedback for menu selection is provided. 5.1.4.1 Format.			

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Checklist	YES	NO	N/A
a) Logically related options within a list are grouped.			
b) Groups are segregated by lines or other means.			
c) Unless constrained by available display space, related menu options are formatted as a single column list.			
d) Menu options are logically ordered and grouped, by frequency of use, importance, functional relations, or sequence of use.			
e) Where ordering cannot be determined by frequency of use, importance, functional relations, or sequence, alphabetic ordering is used.			
f) Menus provided in different displays or contexts are designed so that option lists are consistent in wording and ordering.			
g) Pop-up, pull-down, and windowed menus are displayed in consistent screen locations for all modes, transactions, and sequences.			
h) Menus are distinct from other displayed information.			
5.1.4.2 Labeling and terminology.			
a) An explanatory title for each menu is provided.			
b) Where menu options are grouped in logical subunits, each group is provided a descriptive label that is distinctive in format from the option labels themselves.			
c) Menu options are worded as commands rather than as questions to the user.			
d) When menu selection is used in conjunction with command language, menu option wording is consistent with command language.			
5.1.4.3 Menu option selection.			
5.1.4.3.1 Pointing and selecting.			
a) Menu selection from displayed options is implemented by direct pointing, or indirect pointing devices.			
b) Where direct pointing devices are used in menu selection, a sufficient pointing area is provided to preclude selection errors.			

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Checklist	YES	NO	N/A
c) Where indirect pointing devices are used in menu selection, a large pointing area for option selection is provided, including the area of the displayed option label, plus a half-character distance around the label.			
d) When menu selection pointing is via cursor control keys or tabbing, the cursor is automatically placed at the first listed option.			
e) Experienced users are able to bypass a series of menu selections and make an equivalent command entry directly, without using pointing or cursor control devices.			
f) When equivalent keyboard commands are provided as means of menu selection, they are displayed as part of the menu option label.			
5.1.4.3.2 Key coded menu selection.			
a) Menu selection by keyed entry may be used when menu selection is a secondary or occasional means of control entry, or where short option lists are needed.			
b) Options are coded by the first letter or several letters of their displayed labels, rather than by arbitrary numeric codes.			
c) When menu items are coded, a standard display area for code entry is provided, and the cursor is placed in the command entry area.			
d) Codes associated with each option is displayed in a consistent, distinctive manner.			
e) One (1) letter codes for menu selection, rather than assigning arbitrary letter or number codes, are provided.			
f) Coding of menu options is consistent among display screens and system use contexts.			
5.1.4.4 Hierarchic menu design.			
a) When menu selection must be made from a long list, hierarchic menus for sequential selection is provided, but the number of hierarchic levels is minimized.			
b) Each menu option list has 4 to 8 options, menus with less than 3 options are avoided.			

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Checklist	YES	NO	N/A
c) A general menu of basic options, as the top level menu, is provided which is as unambiguous as possible.			
d) Menu elements subordinate to top level menus are logically related.			
e) Hierarchic menus are structured to permit immediate user access to critical or frequently selected options.			
f) Hierarchic menus minimize the number of steps required.			
g) Users have to make only one control action to move to the next higher level, and a separate simple control action is required to return to the general menu at the top level.			
h) Design and use of hierarchic menus is consistent across task and transaction contexts.			
i) The current position within menu structures is indicated when hierarchic menus are used.			
j) Hierarchic menu control options are distinct from menu branching options.			
5.1.5 Command language dialog.			
a) Once a command has been composed, an explicit enter or execute is provided.			
b) Standard techniques for editing commands is provided.			
c) If a command entry is not recognized, user is able to revise/replace the command.			
d) If a command entry may cause delays, delete or modify data, or have other potentially adverse consequences, the user is required to review and confirm a displayed interpretation of the command before it is executed.			
5.1.5.1 Labeling and terminology.			
a) Command language is designated so that a user can enter commands in terms of functions desired.			
b) Command names and language are meaningful, use familiar wording, and be distinctly and consistently worded.			

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Checklist	YES	NO	N/A
c) Codes are designed to aid memory.			
d) If a system will have many novice or infrequent users, the system recognizes a variety of synonyms or alternative syntax for each word defined in the command language.			
e) Where possible, commands are selected such that common misspelling errors do not represent valid commands .			
f) Words and abbreviations in a command language are distinctive.			
g) Commands do not consist only of non-alphanumeric characters.			
5.1.5.2 Format, syntax and layout.			
a) A standard display area for command entry is provided. When possible, command entry is located at the bottom of the screen.			
b) Command language functions are organized in groups for ease of learning and use.			
c) For infrequent or untrained users, syntactic complexity is minimized.			
d) Command language syntax is consistent across different transactions.			
5.1.5.3 Keying requirements.			
a) Required use punctuation is minimized; where required, a standard delimiter (such as a /) is used.			
b) Blanks in command entry is ignored by the system.			
c) Users are able to use abbreviated forms of any command of more than 5 characters.			
5.1.5.4 Job performance aids.			
a) Users are able to request guidance information necessary to determine required parameters or options in a command entry, or to determine available options for a command.			
b) Where possible, guidance information is accompanied with			

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Checklist	YES	NO	N/A
graphic examples of command content and syntax.			
c) A general list of basic commands, with appropriate command format, is provided.			
5.1.6 Query and natural language dialogs.			
5.1.6.1 Terminology.			
a) The wording of a query specifies what data are requested, not how to find the data.			
b) A query language is designed so that it reflects a natural data structure or organization.			
c) Users are able to employ alternative forms when composing queries			
d) Where possible, need for quantifiers ("less", "without", "excluding") in specifying queries is minimized.			
5.1.6.2 Limiting and combining queries.			
a) When a query may result in a large-scale data retrieval, the user is required to confirm the transaction or take further action to narrow the query before processing.			
b) Query language includes logic elements that permit users to link sequential queries as a single entry, such as "and", "or", etc.			
c) A query language is capable of linking sequential queries by use of statements such as, "of those records retrieved..." or "how many of the remaining candidates..."			
5.1.7 Function keys.			
5.1.7.1 Labeling and identifying.			
a) Function keys are distinctively labeled.			
b) If key function is variable, current active function is appropriately labeled by adjacent screen location or other means.			
c) Function keys status is indicated.			
d) Unneeded or disabled function keys are disabled and so			

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Checklist	YES	NO	N/A
indicated by the system.			
5.1.7.2 Single and double keying.			
a) Keys controlling frequently used, critical, or time constrained functions permit single key action and do not require double keying.			
b) Double-keyed functions are logically paired and consistently logical.			
c) Keys perform labeled functions with a single activation, and do not change its function with repeated activation.			
5.1.7.3 Feedback.			
a) Feedback is provided for function key activation.			
b) When system functioning requires the user to standby, periodic feedback is provided to indicate normal system operation.			
5.1.7.4 Format and layout.			
a) Function keys are grouped in distinctive locations on the keyboard.			
b) Frequently used, important, or critical function keys are placed in the most convenient locations.			
c) The layout of function keys is compatible with their importance.			
d) Physical protection is provided for keys with potentially disruptive consequences.			
5.1.7.5 Modes/function.			
a) When a function is continuously available, the function is assigned to a single key.			
b) Key functions in different operational modes are consistent or similar.			
c) When the functions assigned to a set of keys change as a result of user selection, the user is provided an easy means to return to the base-level functions.			

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Checklist	YES	NO	N/A
d) Where possible, experienced users are able to define their own key functions.			
5.1.8 Iconic interaction.			
a) Icons may be used to graphically represent operations, processes and data structures.			
b) Icons may be used as means of exercising control over system functions, components, and data structures.			
c) Iconic representations are not used when display resolution is low.			
d) If icons are used to represent control actions in menus, a label is associated with each icon.			
e) Icons are consistent and predictable across operating modes and across applications.			
f) Icons are graphically designed to the processes or operations they represent, by use of literal, functional, or operational representations.			
g) Abstract or humorous representations are avoided.			
5.1.9 User transaction interrupts.			
a) Means to interrupt or cancel transactions are provided, are distinctive, and occur only by explicit user action.			
b) User interrupts and aborts do not modify or remove stored or entered data.			
c) As appropriate to specific transactions, the following interrupts are provided:			
1. CANCEL (or UNDO) erases any immediate changes and restore the display to its previous version.			
2. BACKUP returns the display to the last previous transaction.			
3. REVIEW returns to the first display in a defined transaction sequence, permitting the user to review a sequence of entries and make necessary changes. REVIEW is nondestructive.			
4. RESTART or REVERT cancels any entries made in a defined transaction sequence and return to the state at the beginning of the			

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Checklist	YES	NO	N/A
sequence. When data entries or changes will be nullified RESTART action, users are required to CONFIRM the RESTART. 5. END (or EXIT) concludes a repetitive transaction sequence. 6. PAUSE and CONTINUE temporarily interrupts a transaction sequence without change to data or control logic. When PAUSE is selected, a PAUSE status indication is presented. 7. SUSPEND preserves (saves) current transaction status when a user leaves the system, and resume at that point when the user again logs on the system. When SUSPEND is selected, an indication of the SUSPEND status is presented. 5.1.10 Error management. a) Users are able to edit a command during its composition before making an explicit ENTER action. b) Users are able to stop a control process at any point in a sequence to correct an error. c) Interface software deals appropriately with all possible control entries, correct and incorrect. d) System and software is able to distinguish between program errors, equipment failures, and operator errors. e) System and software, where failures result in shutdown, allow for minimum loss of work performed. 5.1.10.1 Error detection. a) If only a portion of a merged command, or an entered string of commands, can be executed, the user is alerted and guidance provided to permit correction, completion, or cancellation of the merged command. b) When an error is detected in a string of command entries, the system either consistently executes to the point of error, or consistently require users to correct errors before execution. c) If a menu selection, function key, command, etc. entered is invalid or inoperative at the time of selection, no action results except a display of an advisory message indicating what functions, options, or commands are appropriate. 5.1.10.2 Error messages. a) Error messages indicate why control input was rejected and			

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Checklist	YES	NO	N/A
what corrective actions may be taken. b) Where possible, error messages distinguish between syntax errors and keying errors. c) Error messages and guidance that will not fit on the display contains references to on-line documentation which will provide further guidance, users do not have to refer to secondary written procedural references. d) Error messages are displayed with the rejected input and the portion of the input in error is highlighted. 5.1.10.3 Error correction and recovery. a) When a command entry is in error, is not recognized or is not appropriate, users is able to correct, without reentering, the command. b) Entry of corrections requires an explicit action, and requires the same ENTER action for reentry that was used for the original entry. c) Easy means to return to the main dialog after error correction is provided.			

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Checklist	YES	NO	N/A
5.2 Data entry.			
5.2.1 General.			
5.2.1.1 System response time and user pacing.			
a) The system acknowledges user inputs rapidly, preferably within 0.2 seconds after data entry.			
b) Users are able to pace data entry, without limitations controlled by computer processing or external events.			
5.2.1.2 Editing during entry.			
a) Users are able to perform simple editing during data entry, without entering special editing modes.			
b) Users are able to change entries by consistent means.			
c) Users are able to enter data via a consistent mode, without having to change modes.			
d) When inserting words or phrases, items to be inserted are displayed as the final copy will appear.			
e) During input data editing, the system automatically displays, or offers to display via prompt, information to be modified.			
5.2.1.3 Data entry feedback.			
a) Data entered appear on the users primary display on a stroke-by-stroke basis.			
b) The system confirms completion of a data entry action by display of confirmation message or other means to indicate successful data entry.			
c) Error messages are displayed to indicate unsuccessful data entry.			
d) Feedback is provided for repetitive data entries by system regeneration of data entries.			
e) The user is alerted when the system cannot interpret or recognize an abbreviated data entry. Where possible, the system questions the user to resolve uncertainty.			

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Checklist	YES	NO	N/A
5.2.1.4 Data entry defaults. a) Where inputs have consistent data, the user is able to define default values, codes or strings. The system carries the data to subsequent forms, text strings, etc. b) When default modes are provided, the user must be able to define, modify, remove, inhibit or enable defaults at any time. c) Users are capable of replacing any data entry default value with a different entry without changing the default definition for subsequent fields. d) On initiation of a data entry, defined default values are automatically displayed and highlighted. e) The user is able to press one key to confirm the default values. 5.2.1.5 Highlighting. a) Highlighting is easily recognizable and be used to attract the users attention to active fields, special conditions, or as a means to provide feedback. b) Highlighting does not interfere with the readability of displayed information. c) A highlighting technique similar to that used on the VDT is provided for printed output. d) Critical data is highlighted and is removed when it no longer has meaning, importance, or criticality. e) Flashing is not used as a means to highlight routine information. f) Flashing is only used as an alerting/alarming code. 5.2.1.6 Data entry fields. a) A clear visual identification of each field is provided. b) Field delineation cues distinguish basic features of required entries.			

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Checklist	YES	NO	N/A
c) Active data entry fields are indicated by highlighting or other means.			
d) Active data entry fields provide data entry prompts.			
5.2.1.7 Explicit user actions.			
a) In general, explicit user actions are required to initiate system processing, such as saving, deleting data or files, and do not occur as a result of other system commands.			
b) An explicit ENTER action is required to initiate processing of entered data; an explicit CANCEL action is required to cancel a data entry; and an explicit DELETE action is required prior to deleting any text or other data.			
5.2.1.8 Keying.			
a) Where possible, users is able to use single keystrokes to enter data.			
b) Required multiple keying is avoided.			
c) For data entry, upper and lower case keys are treated as equivalent.			
d) When entering decimal data, the system recognizes, but does not require, terminal decimal points, and recognizes, but does not require, typing of leading or trailing zeroes.			
e) The system treats multiple and single spaces as equivalent. Users are not required to count spaces.			
f) Keying redundant data, data already known by the system, or data that can be computed or derived is not required except for special conditions such as data security. A glossary links information from a record at time of entry so that keying any of the unique elements will retrieve a whole record.			
g) Coded input data (alpha or numeric) is kept short, preferably not exceeding 5-7 characters.			
h) Long input data strings is partitioned, as in telephone numbers, into shorter groups of three to five characters, separated by blanks, hyphens, or slashes, for both entry and display.			

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Checklist	YES	NO	N/A
5.2.1.9 Analog data input. a) When analog data input is based on graphic presentation of information, analog means of data entry is provided. b) Where analog data is based on previously quantified data, key entry is used in lieu of analog entry. 5.2.1.10 Hierarchical data input. If a user must enter hierarchical data, the system guides the specification of relations in hierarchical structures. 5.2.1.11 Recurrent/derived data input. a) When possible, routine data that can be derived from computer records are entered automatically. b) When possible, computation of derived data is provided. c) Recurrent field entries are retrievable for user acceptance. d) Where data that are logically related to other entries are accessible to the computer, the computer retrieves and enter those redundant data items automatically. e) Cross-file updating is provided by the system. Users do not have to perform cross-file updates. 5.2.1.12 Speech input. a) Speech input is used only when more reliable methods, such as keying or pointing, cannot be used. b) Speech input is not used as a means of transaction control when a large constrained vocabulary may exceed memory capabilities of the user, or for highly complex or nebulous operations. c) A limited speech input vocabulary is used. d) Spoken entries are phonetically distinct. e) Input feedback and simple error correction procedures are provided for speech input. f) Alternative entries for speech input is provided, as in the use of EXIT, FINISHED, and QUIT to terminate a session.			

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Checklist	YES	NO	N/A
g) Provide PAUSE and CONTINUE or RESUME option for speech input.			
h) Where word boundaries are required for system interpretation, boundaries of 100 milliseconds or more is allowed by the system.			
i) A word reject capability is provided.			
5.2.2 Cursor positioning.			
a) Cursors are distinctive and easy to locate at any position on the display.			
b) Cursors are easliy tracked as they move through the display.			
c) Cursors do not obscure, distract or impair searching for information unrelated to the cursor.			
d) Cursor positions remain stable until commanded by the user or the system to move, an explicit action is required to enable or activate a designated cursor position.			
e) Cursor controls provide fast and accurate cursor placement; entry of a designated cursor position is acknowledged within 0.2 seconds.			
f) Control actions for cursor positioning corresponds to direction of cursor movement.			
g) Where cursor positioning is required as part of a keyed data entry task, the cursor control device is located near to, or integral with, the keyboard.			
5.2.2.1 Data entry and cursor placement.			
a) An ENTER action for data items results in entry of all items regardless of where the cursor is placed on the display. The user is not required to move the cursor to a specific field of a display to perform an enter action.			
b) User required actions for cursor movement are minimal for form-filling entry.			
c) The TAB key is used to move the cursor to the next data field.			

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Checklist	YES	NO	N/A
d) The TAB key does not signify ENTER or acceptance of field contents.			
e) Formats are organized to minimize positioning movements of the cursor. If there is a predefined HOME position for the cursor, it is consistently positioned on displays of the same type.			
f) Users are not able to move cursors to data fields which cannot accept data or where existing data cannot be modified.			
5.2.2.2 Gross positioning/pointing.			
a) If proportional spacing or variable sized characters are used, the system automatically places the cursor in the correct position for entering or changing data.			
b) When cursor positioning is accomplished in discrete steps, consistent movement magnitudes are provided for horizontal steps and vertical steps. However, horizontal steps do not need to be of the same magnitude as vertical steps.			
c) When cursors are used in selecting display areas a large area for pointing is provided, including the area of the displayed text label, plus a half-character distance around the label.			
d) When cursor positioning is the sole or primary means of data entry, a direct pointing device is used in preference to incremental stepping or slewing controls.			
5.2.2.3 Precise positioning/pointing.			
a) Where precise pointing is required, as in graphics generation, a point designation feature is provided.			
b) A continuously operable control is used to control direct pointing, rather than discrete controls.			
5.2.2.4 Multiple cursors.			
a) Use of multiple cursors is avoided unless indicated by user task requirements.			
b) Where multiple cursors are used, they are visually distinctive.			
c) An indication of cursors which are active is provided.			

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Checklist	YES	NO	N/A
d) Where separate control is provided for multiple cursors, pointing/control operations are compatible.			
5.2.3 Text entry.			
a) Adequate display capacity is provided to support text entry and editing.			
b) When possible, the system automatically defaults to a standard text input format.			
c) When users can define text entry formats, they are capable of being stored for future use.			
d) Frequently used text segments are separately stored and do not require keying when needed.			
e) Information required for text entry or editing, such as user guidance information, is separately displayed on the display medium, and is distinct from entered or displayed text.			
f) As required by the system and the user task, auditory signals are provided to alert the user to direct attention to the display.			
5.2.3.1 Cursor movement.			
a) When entering or editing text, users are able to freely move the cursor within a displayed page, to specify items for change, and to make changes directly to the text.			
b) Users are able to move cursors by specific units of text, such as by paragraph, line, page, and character.			
c) Users do not have to frequently alter hand positions between a pointing device to position cursors and the keyboard to edit or add text.			
5.2.3.2 Editing.			
a) Users are able to specify units of text in editing and other control tasks.			
b) Users are able to select and move sections of text within a document.			
c) Text specified for control entry is highlighted or otherwise			

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Checklist	YES	NO	N/A
indicated. d) Easy to use commands, such as MOVE, COPY, and DELETE, for adding, inserting, or deleting text segments are provided. ROLL and SCROLL commands refer to the display window such that the display window appears as an aperture moving over stationary text. e) Editing actions are reversible, by use of an UNDO function. f) An explicit action is required to delete sections of text. 5.2.3.3 Page formatting. a) Easy means for users to specify page formats is provided. b) The system provides automatic line breaks when entered text reaches right margins. c) Automatic word-wrap is provided. d) Hyphenation only occurs by user specification. e) Page breaks are under the control of the user. f) Entered text is left justified, and consistent spacing provided between words, unless otherwise specified by the user. g) Natural units of text are provided. h) Control entries which are displayed in text are distinguishable from the main text. 5.2.3.3.1 Pagination. a) The system provides automatic pagination, while providing the user the capability to specify page size. b) If automatic repagination is not provided, a warning message is presented to the user. c) Users are able to override automatic pagination and be able to specify page numbers, at any point in a document. d) The system automatically increments pages at any point after the user specifies a beginning page number.			

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Checklist	YES	NO	N/A
e) Inserting text into a paginated document does not result in loss of information.			
5.2.3.4 Searching text.			
a) Character string search capability is provided and automatically locates the cursor at the occurrence of any matched strings.			
b) Upper and lower case is ignored, unless specified by the user.			
c) A global search and replace capability is provided.			
d) Users are able to specify upper and lower case matches in global search and replace transactions.			
5.2.3.5 Printing.			
a) A display mode is provided which displays text exactly as it will be printed.			
b) Printout options are selectable as well as portions of text to be printed.			
c) The status of selectable printout options is available to the user for review and change.			
d) Printout status information is displayed for the user.			

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Checklist	YES	NO	N/A
5.2.4 Form entry.			
5.2.4.1 Format.			
a) A unique, standard symbol is used for prompting data entry.			
b) Hardcopy forms that are used for inputting, updating, or correcting data corresponds to screen display in terms of order of entry, data grouping, etc.			
c) Where no source documents or forms exist to support data entry, data fields are logically grouped, by sequence and frequency of use, importance, and functional associations.			
d) When entry of data in a field is deferred or omitted, the system identifies the field by highlighting or other means and the user is informed that data have not been input.			
5.2.4.1.1 Field definition/delimiters.			
a) Separate data items are entered without the need for user input of separators or delimiters. If a user input field delimiter is needed, a standard symbol, such as a slash (/) is used.			
b) Special characters is used to delineate data fields and data field lengths.			
c) Data entry by overwriting a set of characters within a field is avoided, deletion/insertion is used instead.			
d) Users do not have to remove unused underscores or otherwise enter keystrokes for each position within a variable length entry area.			
e) Optional vs. required data entries within fields on input forms are distinct.			
5.2.4.1.2 Data field labeling.			
a) Data fields are labeled consistently, uniquely and adjacent to the data input area.			
b) Labels for data fields are visually distinctive, from data fields, prompts, and other information of displays.			
c) Formats are consistent.			

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Checklist	YES	NO	N/A
d) Data field labels appear in upper case only, while entered text may appear in both upper and lower case.			
e) Unless required for user form design, field labels are not editable by users.			
f) Field labels terminate with a special symbol to signify data entry point.			
g) Data fields are descriptively worded by whole words (preferred) or predefined terms, codes, or abbreviations (acceptable).			
h) Arbitrary codes, such as numbering schemes, are avoided.			
5.2.4.1.2.1 Units of measurement.			
a) When units of measurement are consistent within a field entry, field labels identify the appropriate units.			
b) Units of measurement familiar to the user are used.			
c) Where alternative units of measurement may be required for input, an associated field or field modifier is provided.			
d) The user does not have to transform units at time of data entry.			
5.2.4.2 Cursor positioning.			
a) When a new or blank form is presented to the user, the cursor is positioned at the beginning of the first entry field.			
b) User cursor positioning is minimized.			
c) Where the number of fields is limited, screen traversal distances are short, and when data fields will be accessed sequentially, explicit tabbing is available for advancing to subsequent fields.			
d) In complicated forms with many fields, or when field entry will be less predictable, direct pointing devices, such as mouse or lightpen, is available for selecting fields.			
e) The user is not able to position the cursor within protected fields.			
5.2.4.3 Data entry/editing.			

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Checklist	YES	NO	N/A
a) When entering logically related items, the system only requires entry of information which changes through subsequent forms, and this information is located at the end of the form filling transaction.			
b) Users are able to REVIEW, CANCEL, or BACKUP to any field and change any item prior to taking a final ENTER action.			
c) For variable length field entries, automatic justification of the input data is provided.			
d) Unless otherwise required by processing or display requirements, alphanumeric input is left justified, and numeric input is right justified for integer data or decimal point justified for decimal data.			
e) Users do not have to provide a keystroke for every character space reserved by the field.			

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Checklist	YES	NO	N/A
5.2.5 Tabular data entry. a) Where sets of data must be entered sequentially or where data is keyed row by row, a tabular display format is used. b) Information input is automatically justified, without the user having to insert blank/null characters. c) Numeric data is automatically right, or decimal point, justified. d) Users do not have to input leading or trailing zeros. e) Numeric values are displayed to level of significance required of the data regardless of the value of individual input data. f) Every fifth row of a table is separated by a blank line or other delimiter. 5.2.5.1 Cursor positioning/tabbing. Users is able to tab to adjacent fields, across rows or columns. 5.2.5.2 Labels. a) Each row and column is uniquely and informatively labeled and is visually distinct from data entries. b) Where more data fields exist than can be displayed on a single display page, row and column labels remain along the top (or bottom) and left (or right) edges of the display. c) Labels do not scroll off the visible portion of the display.			

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Checklist	YES	NO	N/A
5.2.6 Graphics entry.			
a) When entering and manipulating graphic data, pointing devices is used rather than keyboards.			
b) When pointing is used as medium for graphic input and manipulation, system control uses pointing devices.			
c) Easy means for saving and loading graphic displays is provided.			
d) Users are able to specify graphic display names and to review file catalogs of stored graphics.			
e) When specified by the user, the system provides automatic object alignment to an invisible rule or grid structure. The user does not have to align and space separate "objects".			
f) Where possible, the system validates graphic data input.			
5.2.6.1 Cursors/pointer positioning.			
a) Graphics display cursors are distinctive and have a point which can be used to select/manipulate small graphic objects.			
b) Cursors are easy to position and simple to point to display elements or locations.			
c) Graphic data entry cursors have a movement (pointing) component and an activation component; the movement component positions the cursor while the activation component activates the cursor pointing location in order to manipulate a display element.			
5.2.6.2 Drawing.			
a) Automatic grid alignment for drawn objects is available to users at their request. Users are able to specify grid intervals.			
b) Users are able to scale object sizes, by enlarging or reducing.			
c) Users are able to fill enclosed areas with colors or patterns.			
d) Users are able to select automatic figure completion.			
e) Where possible, general computer models that will allow users to generate specific from general drawings are provided.			

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Checklist	YES	NO	N/A
f) Critical or difficult graphic drawing tasks are supported by a "zooming" function to enlarge critical display areas.			
5.2.6.2.1 Figure generation.			
a) The system automatically draws lines between user specified points and supports the drawing of rectangles, arcs, ovals and other figures.			
b) Objects emerge as they are being drawn.			
c) Users are able to constrain line drawing to exactly vertical or horizontal.			
d) For precise drawing, users are able to specify their geometric relations to other lines.			
e) Alternate methods are provided for drawing objects.			
f) Users are able to copy, rotate, and vertically or horizontally mirror image objects.			
5.2.6.2.2 Grouping/merging objects.			
a) The system automatically merges objects and assign precedence to objects.			
b) The system provides means to group separate objects into a single, grouped object.			
c) Where separately drawn lines must connect at terminal points, the system automatically makes the connections.			
5.2.6.3 Graphic objects, elements and attributes.			
a) Graphic display elements are selectable by the user for manipulation, and element attributes are selectable and editable by pointing to and selecting from displayed examples.			
b) Object attributes are displayed as selected, and are not appended to objects by codes or other means.			
c) Attribute selection/editing methods are consistent.			
d) Activated/selected graphic elements are highlighted or otherwise indicated to the user.			

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Checklist	YES	NO	N/A
e) User selectable objects are easily repositioned, duplicated, or deleted.			

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Checklist	YES	NO	N/A
5.2.6.4 Plotting data. a) When complex graphic data must be entered quickly, computer aids are provided. b) The system/software supports automatic plotting of stored data. c) Where frequently used or constrained graphic formats exist, the system provides graphic templates to the user. d) The system provides for automatic scaling of graphic data and users are able to modify system generated scales. e) When graphic data can be derived from data already in the computer, machine aids are provided.			

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Checklist	YES	NO	N/A
5.2.7 Data validation.			
5.2.7.1 User validation.			
a) The user is able to obtain a paper copy of the contents of alphanumeric or graphic displays.			
b) If information is printed remotely, print status messages are displayed and screen contents are not changed as a result of the print operation.			
c) In repetitive data entry task, inputs are validated at the time of each transaction.			
d) For novice users, the system provides optional item-by-item data validation within a multiple-entry transaction.			
5.2.7.2 System validation.			
a) Where possible, automatic data validation to check data for correct format is provided.			
b) Correct data entries are accepted and processed properly by the computer without need for user involvement to proceed.			
c) Where possible, when a data or command entry does not meet validation logic, a cautionary message is displayed asking the user to confirm data entry.			
d) If data validation detects a probable error, an error message is displayed at the completion of a field/data entry, without interrupting an ongoing transaction.			

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Checklist	YES	NO	N/A
5.3 Data display.			
5.3.1 General.			
5.3.1.1 Display of information.			
a) Information density is minimized in displays used for critical task sequences.			
b) For critical information, a minimum of one character space is left blank vertically above and below critical information, with a minimum of two character spaces left blank horizontally before and after.			
c) Whenever possible, users are able to see the whole page with which they are working.			
d) Data needed for a transaction is displayed in a directly usable form, and only essential data is displayed.			
e) Users are able to control the amount, format, and complexity of displayed data, as necessary to meet task requirements.			
f) Users are able to obtain a paper copy of the exact contents of alphanumeric or digital graphic display in systems where mass storage is limited, mass stored data can be lost by power interruption, or where record keeping is required.			
g) When task performance requires or implies the need to assess currency of information, displays are annotated with date-time information.			
5.3.1.2 Consistency/standardization.			
a) Data is displayed consistently in word choice, format, and basic style, and within standards and conventions familiar to users.			
b) Data display is standardized within applications and across transactions.			
5.3.1.3 Wording/style.			
a) The wording of displayed data and labels incorporate familiar terms and the task-oriented language of the users.			
b) The use of unfamiliar language of designers and programmers is avoided.			

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Checklist	YES	NO	N/A
c) Consistent wording is provided for displays, data and labels.			
d) Consistent grammatical structure for data and labels within and across displays is provided.			
5.3.1.4 Labeling.			
a) Each individual data group, message, or frame contains a distinct, unique, and descriptive label.			
b) Display frame labels are an alphanumeric code, or an abbreviation which is prominently displayed and is short enough (3-7 characters) or meaningful enough to be learned and remembered easily.			
c) Labels are highlighted or otherwise emphasized. The technique used is easily distinguished from that used to highlight or code emergency or critical messages.			
d) Labels are descriptively, consistently and distinctly worded.			
e) Label locations and formats are consistent.			
5.3.1.5 Format.			
a) A consistent organization of display features among displays is adopted.			
b) Different elements of display formats are distinctive within a display, but is consistent across displays.			
c) Blank space is used to structure a display.			
d) Groups of information is separated by blanks, lines, color coding, or other visually distinctive means.			
5.3.1.5.1 Layout.			
a) Display windows are labeled at the top with a title or header which describes the contents or purpose of the display.			
b) At least one blank line between the title and the body of the display is provided.			
c) Where control is exerted via keyboard, the last several lines at the bottom of every display is reserved for status and error messages, prompts, or command entry.			
d) Where users must analyze sets of data to discern similarities,			

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Checklist	YES	NO	N/A
differences, trends, and relationships, displays are formatted so that the data are grouped to facilitate analysis and comparison.			
e) Data fields to be compared on a character by character basis is positioned one above the other.			
f) Where possible, data is grouped by sequence, function, importance, or frequency of use, or by other means such as alphabetic or chronology.			
g) Context for displayed data is provided.			
h) Visually distinctive data fields are provided.			
5.3.1.5.2 Multipage displays.			
a) When a display contains too much data for presentation in a single frame, the data is partitioned into separately displayable pages.			
b) Related data appear on the same page and relations among data sets appear in an integrated display rather than partitioned into separate windows.			
c) Each page is labeled to show its relation to the others.			
5.3.1.6 Coding.			
a) Coding is employed to differentiate between items of information, to call the user's attention to changes in the state of the system, and to indicate important, hazardous, or critical information which requires user action.			
b) Coding by data category is provided where a user must distinguish rapidly among different categories of displayed data that are distributed in an irregular way on the display.			
c) Meaningful codes are used rather than arbitrary codes.			
d) Coding is consistent across displays.			
e) Codes assigned special meaning in a display is defined at the bottom of the display and replicates the code being defined.			
5.3.1.6.1 Alphanumeric coding.			
a) Alphanumeric coding may be used to supplement other coding schemes , but is not used as the sole means to call attention to important or critical information.			

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Checklist	YES	NO	N/A
b) Alphanumeric codes display all letters consistently in either upper or lower case.			
c) When short alphanumeric codes combine both letters and numbers, letters and numbers are grouped together rather than interspersing letters with numbers.			
d) Arbitrary alphanumeric codes that must be recalled by the user are no longer than four or five characters.			
5.3.1.6.2 Auditory coding.			
a) Auditory coding signals are used to alert an operator to critical conditions or operations, as a means of supplementing visual display or as an alternative means of information presentation where visual display is not feasible, and as a means to provide feedback for control actuation, data entry, or completion of timing cycles and sequences.			
b) Noncritical auditory signals are capable of being turned off at the discretion of the user.			
c) A simple, consistent means of acknowledging and turning off alarm signals is provided.			
d) Auditory signals are provided when computer response to a user request is greater than 15 seconds.			
e) Signals are intermittent in nature to allow the user sufficient time to respond. Auditory signals are distinctive in intensity and pitch.			
f) The number of signals to be identified does not exceed four.			
g) The intensity, duration, and source location of the signal is selected to be compatible with the acoustical environment of the intended receiver as well as with the requirements of other personnel in the signal area.			
h) For auditory displays with voice output, different voices are used to distinguish different categories of data.			
i) If computer-generated speech output is used for auditory display, a special alerting signal is provided to distinguish them from routine voice messages.			
5.3.1.6.3 Brightness intensity coding.			
a) Brightness intensity coding may be used to differentiate			

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Checklist	YES	NO	N/A
between adjacent items of information or to code two to three state conditions.			
b)Brightness coding has only one meaning.			
c) Each level of brightness coding is separated from the next nearest level by a 2:1 ratio and discriminates only between two categories: bright and dim.			
d) "Inverse video" may be used to highlight critical items that require user attention. When used, brightness inversion is reserved exclusively for that purpose and not used for general highlighting.			
5.3.1.6.4 Color coding.			
a) Color coding, where appropriate, is used to differentiate between classes of information in complex, dense, and critical displays.			
b) The following reserved color meanings are used:			
RED is used to indicate conditions such as "no-go", "error", "failure", "malfunction", etc.			
FLASHING RED is used only to denote emergency conditions requiring immediate operator action, or to avert personnel injury, equipment damage, or both.			
YELLOW is used to indicate marginal conditions or to alert situations where caution, recheck, or unexpected delay is necessary.			
GREEN is used to indicate that monitored equipment/processes are within tolerance or a condition is satisfactory and that it is all right to proceed with an operation or transaction.			
WHITE is used to indicate system conditions that do not have operability or safety implications, but indicate alternative functions.			
BLUE may be used as an advisory color, preferential use of blue is avoided.			
c) Color may be used to identify data categories when it does not conflict with other color coding conventions and does not conflict with the color associations specified above.			
d) Use of color as a formatting code is subordinate to other methods.			

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Checklist	YES	NO	N/A
e) Color coding is redundant to some other means of coding such as symbology; coding only by color is avoided.			
f) Color coding is not used if the information will be accessed from monocromatic displays or hardcopy printouts, or if users may be deficient in color perception.			
g) Colors is easily discriminable and color coding is used conservatively. Each color represents only one category of displayed data.			
h) Brighter or more saturated colors is used when it is necessary to draw a users attention to critical data.			
5.3.1.6.5 Flash coding.			
a) Flash coding is only used to display an urgent need for user attention.			
b) No more than two levels of flash coding is used.			
c) Flash rate in the range of 3 to 5 Hz is used with equal "on" and "off" intervals. If two flash coding levels are used, the second flashes at less than 2 Hz.			
d) When a displayed item is blink coded, a flashing marker symbol is used rather than blinking the item itself.			
e) Event acknowledgment or flash suppression keys is provided.			
5.3.1.6.6 Line coding.			
a) Line coding by color, including variation in line type and line width may be used.			
b) Underlining may be used to indicate unusual values, errors in entry, and data changes.			
c) Underlining rather than overlining is used.			
d) Coding by line length may be used for applications involving spatial categorization in a single dimension.			
e) Coding by line direction may be used for applications involving spatial categorization in two dimensions.			
5.3.1.6.7 Pattern/location coding. Pattern and location coding may be			

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Checklist	YES	NO	N/A
used to reduce search time by restricting the area to be searched to prescribed segments. 5.3.1.6.8 Shape/symbol coding. a) Symbol coding is used to enhance the transfer of information. b) Symbols are analogs of the event or system elements they represent, be in general use and well-known to the users, and be based on established standards or conventional meanings. c) Symbol heights do not differ more than three sizes. d) Special symbols, such as asterisks, arrows, etc., may be used to draw attention to selected items in alphanumeric displays. e) Use of special symbols is consistent and their meanings unique. f) Shape codes using more than 15 different shapes is avoided. Component shapes may be used in combination. 5.3.1.6.9 Size coding. When used, size coding does not exceed 3 sizes. For size coding, a larger symbol is at least 1.5 times the height of the next smaller symbol.			

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Checklist	YES	NO	N/A
5.3.2 Display control. a) Users are able to tailor information displays by controlling data; selection, coverage, updating, and suppression, and are able to specify data for display. b) An easy means to return to normal display coverage is provided. c) Users are able to control displayed data or enter new data when required by a task. d) As required, users are able to print paper copies of information displayed. e) Users are not required to remember data accurately from one display page to another. 5.3.2.1 Display of control options. a) Screen control locations and control options are clearly and appropriately indicated. b) When a user is prompted by the system for a parameter with a predefined fault, the default value is shown. c) Information that the user must have to manipulate displays is displayed as the control becomes available. 5.3.2.2 Data accession. a) A consistent and easy means of moving through data is provided by windowing, panning, paging or scrolling. b) Paging and windowing are not used when searching through continuous text data. c) Panning and scrolling are not used when searching logically grouped information. 5.3.2.2.1 Scrolling. Scrolling, rather that paging, is used for reading continuous text or lists. 5.3.2.2.2 Pan and zoom. a) When a display exceeds capacity of a single frame, users are able to pan a display frame.			

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Checklist	YES	NO	N/A
b) When a user may need to view data relations, pictures, diagrams, maps, etc., in detail, a zooming capability is provided.			
c) When a display has been expanded by zooming from its normal coverage, a scale indicator of the expansion is provided.			
d) Panning and zooming functions are integrated with scales and other overlayed data, such as scaled marks, range vectors, etc.			
e) An overview position of an expanded section of a display is provided as a user reference to position within a display.			
5.3.2.2.3 Information suppression.			
a) Temporary suppression of displayed data may be provided when information is not needed to support task conduct. Information suppression is indicated on the display.			
b) An indication of changes of significant suppressed data is provided.			
c) Users are provided with means to quickly restore suppressed data to the display.			
5.3.2.3 Labeling and marking information.			
a) When a user can select/manipulate data displays, each display has an identifying label and other identifying information to support display control and data access.			
b) Identifying labels are located in a prominent and consistent location and are unique, short and meaningful.			
c) Annotating displays of continued data is provided.			
d) Paging vs. scrolling labels is consistently distinct and unambiguous.			
e) Labeling for display paging is referred to in functional terms.			
f) When lists of numbered items exceed one display page, items are numbered continuously in relation to the first item on the first page.			
5.3.2.4 Display regeneration/data update.			
a) Where users must accurately read changing data, the data is displayed long enough to read to the level of precision required.			

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Checklist	YES	NO	N/A
b) Rate of display regeneration does not exceed user perceptual and information processing capabilities.			
c) Changing alphanumeric data which must be reliably or accurately read are not updated more often than once per second.			
d) When the information displayed is to be considered real time, changing values which are used to identify rate of change or to read gross values are not updated faster than 5 times per second, nor slower than 2 times per second.			
5.3.2.4.1 User/system control.			
a) Unless directed by task, system, or mission requirements, users are able to initiate display regeneration.			
b) The rate of information update is controllable by the user and is determined by the use to be made of the data.			
c) When data is changed via automatic processing, data updates are temporarily highlighted or otherwise marked.			
5.3.2.4.2 Freeze frame.			
a) When displayed data are automatically updated, users are able to "freeze" the display to examine changed data more deliberately.			
b) When frozen, the display is clearly labeled, and users are warned if some significant data change has occurred due to subsequent processing or sensing.			
c) When resuming update after display freeze, display update resumes at the current real-time point unless otherwise specified by the user.			
5.3.2.4.3 Data extrapolation. When needed, a prediction display extrapolating dynamic display information is provided.			

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Checklist	YES	NO	N/A
5.3.3 Voice displays. Voice displays may be used to supplement visual displays when communication flexibility is necessary, when coded signal meanings are numerous or may be forgotten, for presentation of complex directions or instructions, when ambient noise may mask simple tonal signals or in conjunction with tonal signals, and for presentation of continuous information where rate of change is low.			
5.3.3.1 Word selection.			
a) Words selected is appropriate to the task/information presented, concise, and intelligible.			
b) Where possible, words that rhyme and may confuse message interpretation are not part of the spoken lexicon, or are not presented within the same message.			
c) Use of slang is avoided.			
d) Words with more than one syllable are used.			
e) Alphanumeric data is presented using phonetic alphabets.			
5.3.3.2 Presentation.			
a) Spoken messages are produced in the form of the "average talker", in an American English accent without regional dialects.			
b) Speech intensity is appropriate to the expected ambient noise environment.			
c) Within a typical office space intensity is approximately 70 to 75 dB sound pressure level.			
d) Signal to noise ratios is at least 5:1.			
e) Audio signal power is approximately 300 milliwatts at the listeners ear.			
f) Speech signals fall within the range of 200 to 6100 Hz.			
g) Spoken warning messages are preceded by an alerting signal. Users are required to acknowledge spoken warning signals.			
h) Messages are brief, informative, and to the point.			

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Checklist	YES	NO	N/A
5.3.4 Windows. a) Window overlays may be provided to temporarily add data to a display, or as a means to control or display divergent information, or to segregate and control separate operations. b) The display screen is capable of displaying each of the windows simultaneously, in either a tiled or overlapped format, as requested by the user. c) Windows are predefined and displayed under user control, as appropriate. d) Window overlays are nondestructive and do not permanently erase overlayed data. 5.3.4.1 Format. a) Default formats represent the "configuration" of the information to be displayed, and the expectations and experience of the typical user. b) The size and shape of the initial presentation of a window is consistent with its contents. c) Windows which are dedicated to command entry by keyboard input are located at the bottom of the display area. 5.3.4.2 Labeling and identification. a) Windows must be visually separated from each other and from their background, preferably by borders or similar demarcation. b) Windows are identified by a label consistently located at the top of the window's border. Where several windows can be displayed at one time, active windows are indicated by labeling or other means, and an easy means of shifting among windows are provided. c) Labels remain on the screen while the data scrolls beneath them. 5.3.4.3 Operation. In addition to the guidelines below, the guidelines of Section 5.3.2 "Display Control" also applies. a) Windows are consistent in terms of command syntax and semantics. Control of window operations are consistent throughout the system.			

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Checklist	YES	NO	N/A
b) As appropriate to the user task, windows are capable of the following operations: scrolling/panning, resizing, moving, hiding, activating, deactivating, copying to/from, zooming in/out, tabbing, and undo-last.			
c) For text-only windows and windows used for scanning data, window sizing is constrained such that the smallest possible window will contain at least 2 lines of text /data.			
d) Each window has variable line widths selectable by the user.			
e) Keyboard input affects only the active window designated by the user.			
f) Users are able to specify and select separate data windows that will share a single display frame. The system provides the user several options for moving between active windows.			
g) Within a session, the system keeps track of the windows that are open and display them as a menu.			
h) Automatically updated windows have display freeze capability. When a window displays automatically updated information, the user has control over the rate at which automatically updated screens are scrolled .			
i) A window that is not displayed is capable of sending and receiving information.			
5.3.4.4 Feedback.			
a) The system provides immediate and unambiguous feedback concerning which active window is being acted upon.			
b) When the user is communicating with a closed window, the system provides feedback designating the window(s) involved.			
c) If windows are capable of different modes, the system provides immediate and unambiguous feedback concerning which mode is active.			
d) When a display is frozen, the system provides immediate and unambiguous feedback and the user is prompted to return to automatic update.			
e) A warning flag is displayed to alert the user to significant changes in real-time data that occurred while the display was frozen.			
f) If a user-requested action would result in lost or damaged data,			

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Checklist	YES	NO	N/A
the user is alerted and alternative actions recommended. g) The system is capable of alerting the user to critical information that becomes available in an inactive window. 5.3.5 Data forms. Forms are used to display related sets of data in separately labeled fields. 5.3.5.1 Format. a) Visually distinctive fields are provided. b) When forms are used for data entry as well as for the data display, the format for data display is compatible with whatever format is used for data entry. The same item labels and ordering for both is used. c) The ordering and layout of corresponding fields is consistent among displays. 5.3.5.2 Data presentation. a) Units of measurement for displayed data is presented in the label or as part of each data item. b) Long data items of mixed alphanumeric characters is divided into subgroups of three or four characters separated by a blank or by other symbol. c) The internal format of frequently used data fields are consistent from one display to another. d) Blanks (keyed spaces) are distinguishable from nulls (no entry at all) in the display of data forms. 5.3.5.3 Data field labels. Each data field is identified with a display label which is located close to the data fields they identify.			

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Checklist	YES	NO	N/A
5.3.6 Text.			
5.3.6.1 Format.			
a) Consistent text formats are provided from one display to another, and conform to MIL-STD-490.			
b) When tables and graphs are associated with text, they are placed as closely as possible after the first reference within the text.			
c) Information is placed in groups to permit the user to associate or compare similar classes of information.			
d) Grouping may be accomplished by right or left justification of columns to establish boundaries of group areas, spacing between groups, lines between group areas or under group headings, and locating items to be compared character-by-character in subsequent lines on the display.			
e) When words in text displays are abbreviated, each abbreviation is defined in parentheses following its first appearance.			
f) Critical passages/information is highlighted by bolding/brightening, color coding or other means. Capitalization alone is not used.			
g) Where possible, series of related text is displayed in a list rather than as continuous text.			
5.3.6.1.1 Lists.			
a) Unless dictated by the amount of information to be presented, or where information is to be composed, lists are formatted so that each item starts on a new line.			
b) When a single item in a list continues for more than one line, items are marked so that the continuation of an item is obvious.			
c) When listed items will be numbered, Arabic rather than Roman numerals are used.			
d) Leading zeroes are not used unless required for clarity.			
e) A space is placed after every third or forth digit.			
f) Item numbers begin with one, not zero. Numbering starts with one when it applies to counting and with zero when it applies to measurement.			

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Checklist	YES	NO	N/A
g) Lists are arranged is a recognizable order, such as cronological, alphabetic, sequential functional, or importance.			
h) Where a list is displayed in multiple columns, the items are ordered vertically within each column.			
i) For a long list extending more than one displayed page, the last line of one page is the first line of the next page.			
j) For hierarchical lists, such as outlines, complete identifiers are used rather than omitting the repeated elements.			
k) Identifiers are not indented, but titles and subtitles are indented so that their structure is apparent.			
5.3.6.1.2 Free running text.			
a) Lengthy textual material is displayable in hardcopy form rather than requiring the user to read it on-line.			
b) When a user must continuously read text on-line, at least four lines of text is displayed at one time.			
c) Text is presented in mixed upper and lower case.			
d) Text is formatted in a few wide lines containing at least 50 characters per line, rather than in narrow columns of many short lines.			
e) Displayed paragraphs of text is separated by at least one blank line. Paragraphs are numbered.			
f) Consistent spacing between the words of displayed text is provided with left justification of lines and ragged right margins.			
g) Left and right justification may be used if it can be achieved by variable spacing, maintaining constant proportional spacing between and within words, and consistent spacing between words in a line.			
h) Computer-generated displays of textual data, messages, or instructions follow design conventions for printed text.			
5.3.6.2 Wording/style/punctuation.			
a) Text displays and text composed for user guidance is concisely, clearly and simply worded, and simple sentence structures are used.			
b) Distinct words rather than contractions or combined forms are used in displayed text.			

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Checklist	YES	NO	N/A
c) Where possible, affirmative statements rather than negative statements are used, and sentences are composed in the active rather than passive voice.			
d) When a sentence describes a sequence of events, it is phrased in that order.			
e) Use of hyphenation is minimized and conventional punctuation is used.			
5.3.6.3 Display control.			
a) When the user is scrolling vertically through text, the present and end locations are displayed on the viewable portion of the display.			
b) Speed of text display is controllable and does not exceed the users normal reading speed.			

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Checklist	YES	NO	N/A
5.3.7 Tables.			
5.3.7.1 Format.			
a) In tables with many rows or columns, a blank line, dots, or other distinctive features are inserted after every third to fifth row or column. The columns in a table are separated by blank spaces, or by some other distinctive feature.			
b) Tabular data is organized in a consistent, recognizable pattern. Tabular data is displayed in a left-to-right, top-to-bottom array.			
c) When tabular data extend over one page vertically, the columns are labeled identically on each page.			
d) Tabular data does not extend horizontally over more than one page.			
e) Consistent spacing within a table, and from one table to another, is maintained.			
5.3.7.1.1 Numeric data.			
a) Data are presented to the operator in a readily usable and readable format.			
b) Requirements for transposing, computing, interpolating, or mentally translating into other units or numerical basis is avoided.			
c) Columns of numeric data are justified with respect to a fixed decimal point. If there is no decimal point, then numbers are right-justified.			
d) In presenting decimal numbers, trailing zeroes are presented to the level of significance of the number.			
e) For hierarchical lists with compound numbers, complete numbers are displayed.			
5.3.7.1.2 Alphanumeric data.			
a) When five or more alphanumerics are displayed, without a precedent grouping organization, characters are grouped in blocks of three to four characters. If a series is to be 10 units, then its structure has distinct groups of 3, 4, 3. Groups are separated by a minimum of one blank character.			
b) When grouping alphabetic characters, acronyms or			

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Checklist	YES	NO	N/A
abbreviations are used in preference to randomly selected characters that have little relevance to the system.			
c) Complex coding systems use a combination of alpha and numeric designators and grouping is applied.			
d) Columns of alphabetic data is left justified.			
5.3.7.1.3 Reference tables.			
a) When tables are used for reference, items are located in the left column, and display the material most relevant for user response in the next adjacent column. Associated but less significant material is displayed in columns further to the right.			
b) All displayed data necessary to support a user activity or sequence of activities is grouped together.			
c) When data fields contain a naturally occurring order, such order is reflected in the organization of the field.			
5.3.7.1.4 Data comparisons. A tabular format for data display is used when information handling requires detailed comparison of ordered sets of data. Where data items must be compared on a character-by-character basis, data are vertically structured.			
5.3.7.2 Labeling/identifying data.			
a) Each individual field is labeled. The user does not have to rely on contextual clues alone to identify a field.			
b) Table row and column labels are presented in terms familiar to the user.			
c) Labeling units of measurement are part of column labels, or placed after the first row or column data entry.			

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Checklist	YES	NO	N/A
5.3.8 Graphics.			
a) Graphics displays are used when displaying data showing relations in space or time, when users must quickly scan and compare related sets of data, or when users must monitor changing data.			
b) Consistent logic, standard formats, and labeling are provided each method of graphic presentation.			
c) Graphically displayed information is limited to user information needs and task requirements.			
d) Critical data is highlighted.			
e) When needed to view graphics, pictures, diagrams, or maps in detail, zooming capability is provided.			
f) When a display has been expanded from its normal coverage, a graphic indicator of the position in the overall display of the visible section is provided.			
g) A scale is provided for maps and related displays.			
h) When on-line graphic displays must be printed, users are able to display the material exactly as it will appear in the printed output.			
5.3.8.1 Format.			
a) Label formats are consistent.			
b) As needed to support user tasks, reference indices, baselines and text annotations are included in graphic displays.			
c) Textual data annotation is provided where precise information is required.			
d) Normal orientation for labels is used.			
5.3.8.2 Coding and symbology.			
a) Symbol meanings are standard and look like the objects or processes they represent.			
b) When used, simple texture codes are used rather than elaborate patterns.			
c) Where possible, the movement of data elements under			

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Checklist	YES	NO	N/A
computer control has an animation quality.			
d) Where sequential relations between display elements requires highlighting, animation may be used.			
5.3.8.3 Curves and line graphs.			
a) Curves and line graphs are used for displaying relations between two continuous variables, as in showing data changes over time.			
b) Unless required, use of three-dimensional scales is avoided.			
c) Curve and line graphs convey enough information to allow the reader to interpret the data without referring to additional sources.			
d) When curves must be compared, they are displayed in one combined graph.			
e) Figure and title elements are clearly identified.			
5.3.8.3.1 Axes.			
5.3.8.3.1.1 Design.			
a) The horizontal (X-axis) used to plot time or the postulated cause and the vertical (Y-axis) is used to plot a caused effect.			
b) When graphed data represents only positive numbers, the graph is displayed with the origin at the lower left.			
c) When the data include negative values and the axes extend in both directions from a zero point, the origin is displayed in the center of the graph.			
d) Unless required for classification, use of broken axes is restricted.			
e) When scaled data will contain extreme values, the X-axis appears at both the top and bottom, and the Y-axis appears at both the left and right sides of the graph, and grid lines are provided.			
5.3.8.3.1.2 Markings and labels.			
a) Values on an axis increase as they move away from the origin.			
b) Both the X-axis and Y-axis are clearly labeled with title, symbol, and units.			

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Checklist	YES	NO	N/A
c) Logical, mathematical subdivisions are indicated along each axis. Each axis interval is marked; but to avoid clutter, usually only every other interval is marked.			
5.3.8.3.2 Scales.			
a) Each scale axis is labeled clearly with its description and measurements units.			
b) Where users must compare graphic data across a series of charts, the same scale for each chart is used. When users must compare aggregate quantities within a display, or within a series of displays, scaling of numeric data begins with zero.			
c) Graphs have a single scale for each axis. Where possible, common scales for complex graphics are provided.			
d) Linear scales are used in preference to logarithmic or other non linear scales.			
e) Except where convention or customary divisions exist, scales are constructed with graduations at standard intervals of 1,2, 5, or 10 (or their multiples by 10) for labeled divisions. Intervening graduations are consistent with the labeled scale interval.			
5.3.8.3.3 Legends. Where possible, each curve within a single graphic is identified directly by an adjacent label, rather than by a separate legend. If a legend is displayed, the codes are ordered in the legend to match the spatial order of their corresponding curves in the graph itself.			
5.3.8.3.4 Multiple curves.			
a) In charts displaying multiple curves, curves representing data of particular significance are highlighted.			
b) Line coding to distinguish curves is provided. Consistent line codes are used to represent corresponding data in a series of charts.			
c) Curves representing planned, projected or extrapolated data is distinguishable from solid curves representing actual data.			
d) Where curves must be compared to a critical value, a reference index in the chart is provided.			
e) Where users must evaluate the difference between two sets of data, a difference curve is displayed.			
f) Where curves represent cyclic data, extending the graph to			

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Checklist	YES	NO	N/A
repeat uncompleted portions of the displayed cycle may be provided.			
5.3.8.3.5 Surface charts.			
a) When curves represent all of the portions of a whole, surface charts may be used to display aggregated amounts.			
b) The areas defined below the curves are textured or shaded.			
c) Data categories in a surface chart are ordered such that the least variable curves are displayed at the bottom and the most variable at the top.			
d) Where space permits, areas of surface charts are labeled directly within the textured or shaded bands.			
e) Cumulative curves may be used to show cumulative totals. Cumulative curves are not used to extract quantitative or rate of change data.			
5.3.8.3.6 Grids.			
a) When necessary grids, are provided to aid in data interpretation.			
b) Grids are unobtrusive, thinner than data curves, and are invisible behind depicted objects and areas such as the bars on a bar chart.			
5.3.8.4 Bar charts and histograms.			
a) Bar graphs may be used when comparing a single measure across a set of several entities or for a variable sampled at discrete intervals.			
b) Histograms may be used when there are a great many entities or intervals to be plotted.			
5.3.8.4.1 Format.			
a) In a related series of bar graphs, a consistent orientation of the bars is adopted.			
b) When data must be compared, bars are adjacent to one another. Adjacent bars are spaced such that a direct visual comparison can be made without eye movement.			
c) A reference index is provided when displayed values must be			

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Checklist	YES	NO	N/A
compared with some critical value.			
d) Stacked bars may be used. Order of segment stacking is by variability of each segment, with the least variable segment being the lowest or leftmost segment, and the most variable segment being the highest or rightmost segment.			
e) Use of iconic representations of quantitative information, such as when a silhouette of a person represents 1000 people, is avoided.			
5.3.8.4.2 Coding/labeling.			
a) Charts and axes are clearly labeled.			
b) Important, critical or frequently referenced information is highlighted.			
c) When bars are displayed in pairs, they are labeled as a unit, with a legend or individual distinguishing labels for each bar.			
5.3.8.5 Flowcharts. Flowcharts may be used for schematic representation of sequences or processes, as an aid to problem solving.			
5.3.8.5.1 Format.			
a) Flowcharts are ordered so that displayed steps follow a logical order.			
b) When there is no inherent logic in a flowchart, steps are ordered to minimize flowchart size.			
c) The displayed path of flowcharts is from left to right, from top to bottom, or clockwise.			
d) Decision points require a single, simple decision.			
e) Decision options are logically ordered.			
f) Decision block outcome paths are consistent.			
5.3.8.5.2 Coding/labeling.			
a) Symbol/shape coding and line coding is used to assist in identifying elements and flow lines. For different types of flowchart elements, a consistent coding scheme is followed.			
b) Legends are displayed on each figure and title and each element is clearly labeled.			

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Checklist	YES	NO	N/A
c) Critical steps/processes in a flowchart are highlighted.			
5.3.8.6 Maps and situation displays. Maps and situation displays are used to display geographic data, i.e., direction and distance relations among physical locations.			
5.3.8.6.1 Format.			
a) Orientation of maps and situation displays are consistent or under user control.			
b) When maps present large geographic areas, a consistent method of projecting the earth's curvature on a flat display surface is specified and adopted.			
c) Distance judgments from map displays are supported through grid overlays, pointing devices, or other means.			
5.3.8.6.2 Coding/marking/labeling.			
a) When it can be done without cluttering, significant features of a map are labeled directly on the display.			
b) When different areas of a map must be defined, or when the geographic distribution of a variable must be indicated, color or other means of coding is provided.			
c) Where users must make relative judgments for different colored areas of a display, tonal codes rather than spectral codes are used.			
d) Texture, pattern or tonal variation coding are selected so that the darkest and lightest shades correspond to the extreme values of the coded variable.			
e) Highlighting is used to represent data of particular significance.			
5.3.8.6.3 Data presentation.			
a) Where possible, demographic or other data on map displays are presented graphically rather than by using text descriptions.			
b) When it is necessary to show the geographic location of changing data, auxiliary graphic elements are combined with a map background.			

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Checklist	YES	NO	N/A
c) A stable reference for changing data is provided.			
d) When map or situation data categories are variable, the user is able to select the categories needed for information presentation.			
e) Complex data analysis is supported by computer processing.			
5.3.8.6.4 Display control.			
a) When a map exceeds the capacity of a single display frame, in terms of extent and detail of coverage, panning rather than paging over the area is provided.			
b) When a user pans over an extended display, an indication of the position in the overall display is provided.			
5.3.8.7 Pictures and diagrams.			
a) Pictorial displays are used to show representations of real or imaginary objects or processes.			
b) Diagrams are used to show spatial relations, with selective focus on the data specifically required by a user's task where a full pictorial rendering might be unnecessarily complicated.			
5.3.8.7.1 Coding/labeling.			
a) Abstract symbols and iconic representations may be used to denote objects within pictures and diagrams.			
b) Symbols are standardized and a legend defining symbols is displayed or available at user option.			
c) Picture or diagram data of particular significance is highlighted.			
5.3.8.7.2 Display control.			
a) Where a user must examine an object from different perspectives, the user is able to rotate the displayed image.			
b) When users must analyze pictorial images in detail, computer aids are provided.			
c) When diagrammed data exceed the capacity of a single display frame and must be shown in separate sections, an overview of the diagram is provided.			

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Checklist	YES	NO	N/A
d) A logical linking of a diagrams various sections, and an easy means of movement from one section to another, is provided.			
5.3.8.8 Pie charts.			
a) A pie chart is used only to show the relative distribution of data among categories.			
b) Pie charts are not used when the viewer is to extract quantitative information.			
5.3.8.8.1 Format.			
a) Partitioning is limited to five segments or less.			
b) Segments are labeled and numbers provided to their segment labels to indicate the percentage or absolute values represented in the display.			
c) When a segment of a pie chart requires emphasis, it is highlighted by special hatching or shading or by displacing it slightly from the remainder of the pie.			
5.3.8.8.2 Coding/labeling.			
a) The chart and each segment is clearly labeled. If a segment is too small to contain the label, the label is placed outside the segment with a line from it to the segment.			
b) When required, quantitative information is provided on the chart.			
5.3.8.9 Scatterplots.			
a) Scatterplots are used to display variable correlations.			
b) Data of particular significance is highlighted.			
c) When scatterplots are grouped in a single display to show relations among several variables, means to highlight selected relations are provided.			

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Checklist	YES	NO	N/A
5.4 Job performance aids.			
5.4.1 General. In addition to the guidance which follows, job performance aids display design also follow the guidance provided in Section 5.3, "Data Display".			
5.4.1.1 User control.			
a) Standard procedures are designed for similar, logically related transactions.			
b) When techniques adopted for user guidance may slow experienced users, alternative modes are provided which allows bypassing standard guidance procedures.			
c) Explicit actions are required to access or suppress job performance aids.			
d) Users are able to switch easily between information handling transactions and presentation of guidance material.			
5.4.1.2 Format.			
a) Display formats are consistent and readily distinguishable from displayed data.			
b) Critical user guidance is highlighted using the same methods used to highlight critical items in data display.			
c) When hierarchic menus are used, they are organized and labeled to guide users within the hierarchic structure.			
d) A standard symbol is used for prompting entry.			
5.4.1.3 Wording and style.			
a) Wording is familiar to the user, oriented to the task, provide guidance directly.			
b) Active rather than passive voice is used in guidance messages.			
c) Messages are worded concisely, using consistent grammatical structures, phrasing and punctuation.			
d) When transactions occur by a sequence of steps, the same sequence is used in the wording of user guidance.			

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Checklist	YES	NO	N/A
e) Coding abbreviations and wording conventions follow the display design guidance presented in section 5.3.6, "Text".			
5.4.1.4 Speech output.			
a) Computer-generated speech output may be used for guidance messages in environments with low ambient noise, when a users attention may not be directed toward a visual display, or when providing a visual display is impractical.			
b) Computer-generated speech messages are limited in number, distinctive from routine messages, short and simple.			
5.4.1.5 Performance monitoring.			
a) In applications where skilled user performance is critical to system operation, automatic computer recording and assessment of user performance is provided, in terms of: data accessed, user errors, help requests, user transactions and programs used.			
b) Users are informed of any records kept of individual performance.			
5.4.1.6 On-line training. Where possible, on-line training capability is provided with different levels of training for on-line job support and adapt automatically to user abilities.			

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Checklist	YES	NO	N/A
5.4.2 Data display.			
5.4.2.1 Help displays.			
a) Users are able to request help and obtain detailed on-line guidance by using standard actions that are always available.			
b) Synonyms for standard terminology are recognized by help routines.			
c) Multilevel help is under user control. Users are able to browse through on-line help displays.			
d) Help messages are tailored to task and transaction.			
e) Requests for help in ambiguous contexts initiates a dialog in which the user can specify what data, message or command requires explanation.			
f) After requesting help, the user is provided with easy means to return to the main dialog.			
5.4.2.2 Information presented.			
a) Specific user guidance information is available for display at any point in a transaction sequence.			
b) Only guidance information relative to transactions of interest is displayed.			
c) During transaction sequences, guidance is provided telling the user how to continue.			
5.4.2.2.1 Status information.			
a) Indication of system status is continuously presented to users.			
b) Active operational modes are clearly indicated to the user.			
c) Users are able to obtain status information concerning current alarm settings, in terms of dimensions (variables) covered and values (categories) established as critical.			
d) When interaction is required with other users or systems, information concerning the others status is provided.			

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Checklist	YES	NO	N/A
e) Level of system performance is indicated.			
5.4.2.2.2 Control information.			
a) A general list of help control options are available and are displayed in logical groups.			
b) Where command entry is used, an on-line command index is available.			
c) Control options that are specific to individual help messages are indicated on the display.			
d) Advisory messages or prompts are provided to guide users in accessing help messages.			
e) Reference material describing system capabilities and procedures is available for on-line display.			
f) Users are not required to memorize lengthy sequences or to refer to secondary written procedural references to access help messages.			
g) Where the user can choose help data to display, an on-line index is provided.			
h) When a user help request depends upon context established by previous entries, an indication of that context is provided to the user.			
i) Users are able to request a displayed record of past transactions.			

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Checklist	YES	NO	N/A
5.4.3 Feedback.			
5.4.3.1 Routine feedback. Computer response to user entries is rapid, with consistent timing as appropriate for different types of transactions.			
5.4.3.1.1 Information presented.			
a) Routine feedback is provided as transactions are processed and completed.			
b) Feedback is provided for all user interrupts, indicating when the system has returned to a previous or normal status.			
c) Indication of transaction status is provided whenever complete processing will be delayed.			
d) When requests for printed output are handled by a remote printer, feedback for print requests is provided.			
5.4.3.1.2 Format.			
a) Displays are uniquely identified at the top of each display frame.			
b) Selected or active options are displayed automatically or at user request.			
c) Items selected to perform operations are highlighted.			
5.4.3.2 Error feedback.			
a) Error feedback is provided if an error or other unexpected event prevents processing and is displayed within 2 seconds of the entry in which the error is detected.			
b) An error message is not generated as wrong data are keyed, but only after an explicit ENTER action has been taken.			
c) To supplement on-line guidance, system documentation contains a listing and explanation of all error messages.			
d) Conditions requiring special user attention use distinctively coded alarms.			

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Checklist	YES	NO	N/A
5.4.3.2.1 Information presented. a) Error information reflects the user's point of view in terms of what is wrong and what can be done. b) When multiple errors are detected in merged commands, the user is notified of each occurrence. c) When a user repeats an entry error, feedback is distinguishable from the first occurrence to avoid uncertainty whether the computer has processed the revised entry. d) Erroneous entries and error messages are displayed until corrections are made, and are not displayed after the error has been corrected or is no longer applicable. e) When a process is completed or aborted by the system, the user is informed about the outcome of the process and any requirements for subsequent actions. f) The user does not have to search through reference material to interpret system messages. However, error messages may refer the user to specific on-line documentation. g) When possible, users are able to request more detailed error messages. 5.4.3.2.2 Wording and style. a) Error messages are informative, nonthreatening, brief, as specific as possible, and employ neutral wording. b) Wording for error messages is appropriate to a users task. 5.4.3.2.3 Cursor positioning. The cursor is positioned at the point where an error was detected. 5.4.3.2.4 User response. a) Users are required to reenter only the portion of a data/command entry which is not correct and do not have to rekey an entire command string or data. b) Users are required to confirm destructive entries before they will be executed by the the computer.			

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Checklist	YES	NO	N/A
5.5 Expert systems.			
5.5.1 General.			
a) Expert system development is based on: user requirements; preferred dialog types; knowledge engineer requirements; operational requirements; and mental models employed by the human expert and the user.			
b) A detailed description of the functional transactions between the system and user is developed and validated prior to specifying the internal structures of the system.			
5.5.1.1 Representing causality.			
a) To the extent possible, the expert system is capable of identifying and representing causality between facts contained in its knowledge base.			
b) At the request of the user, the expert system is capable of representing forward causality, in the form of predictions, and backward causality, in the form of speculative reconstruction of events.			
5.5.1.2 Specify domains.			
a) In selecting knowledge (facts) to be contained in the knowledge base, both a domain model and a set of domain principles are established.			
b) The domain model contains descriptive causal relationships and classification hierarchies, including: failure modes, conditions and effects; symptoms; measures/estimates of criticality/priority; and, alternative responses.			
c) The set of domain principles contain prescriptive methods and heuristics, including: hypotheses to be developed; data to be acquired; tests to be conducted; and, decisions to be made.			

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Checklist	YES	NO	N/A
5.5.2 Dialog. a) The system supports a flexible dialog that permits either the user or the expert system to initiate an action or request for information, without cancelling an ongoing transaction. b) The user-expert system dialog is flexible in terms of the type and sequencing of user input it will accept. c) When inexperienced users are required to interact with the expert system, menu, form filling, query or question/answer dialog modes are preferred over command language dialog modes. d) The system is designed to permit rapid retrieval of previous exchanges between the user and the expert system for the current transaction. The preferred method for such retrieval is scrolling. e) User-expert system information exchange is based on: the range of data types which will be input by the user; the extent and frequency of each data type entry; how user-generated data be acquired; the range of data types which will be output by the expert system; the extent and frequency of each data type output; and pacing of user queries. f) For the mode of expert system dialog selected, the appropriate guidelines of section 5.2, "Dialog/Interaction Control", also apply to expert systems dialog design.			

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Checklist	YES	NO	N/A
5.5.3 Problem statement/input.			
5.5.3.1 Problem definition and consultation planning.			
a) The expert system provides the capability for the user to plan a strategy for addressing a problem. This plan may include data to be acquired, hypotheses to be tested, criteria for accepting/rejecting hypotheses, etc.			
b) The capability provided by the expert system includes: planning aids; an evaluation function which assesses the adequacy of the user's plan and recommends revisions where necessary; the ability to form, state and test hypotheses in a manner consistent with the user's plan; and, the capacity to store and recall plans.			
5.5.3.2 Consultation.			
a) The expert system is capable of supporting a complete range of problem solving strategies, including: reliability; conditional probability; syndrome/symptom analysis; signal tracing; half-split; and, bracketing.			
b) The expert system is capable of accepting direction from the user in terms of which strategy to employ.			
c) The control strategy supports both forward (data-driven) and backward (goal-driven) chaining to allow the user or expert system to provide data or propose a new or revised goal, as appropriate, for the transaction underway.			
d) The system is capable of supporting speculative analysis by providing a "reconnoiter mode" that allows the user to investigate the effects of an action without actually implementing the action.			
e) Entering a reconnoiter mode requires an explicit command by the user and results in a clearly distinguishable change in system output to ensure that the user is apprised of the change in operating mode.			
f) The expert system is capable of providing interactive explanations using the facts and rules contained in its knowledge base.			
g) The knowledge required to perform all functions allocated to the expert system is directly accessible by the expert system.			
h) Requirements for the expert system to query the user to obtain information for routine functions are minimized.			
i) The capability for the user to supercede the current request for information from the expert system in order to input information related to a different transaction is provided.			

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Checklist	YES	NO	N/A
j) The user does not have to complete all elements of an expert system requested form in order to complete a phase of a transaction.			

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Checklist	YES	NO	N/A
5.5.4 Display.			
5.5.4.1 Dynamic information.			
a) With the exception of mission-critical information, display of dynamic information "freezes" during extended explanation sessions to ensure that a significant change in status does not escape notice by the user.			
b) At the completion of the explanation session, the system updates and highlights any changes in displayed values, and request acknowledgment by the user.			
c) If mission-critical information becomes available during an extended explanation session, the system alerts the user, via prompts or other alarm mechanisms, and immediately displays the information to the user.			
5.5.4.2 Graphics interface.			
a) The expert system has the capability to graphically represent its rules network. This capability is available to the user as an adjunct to the explanation subsystem.			
b) Graphics, such as a system schematic, is used to depict relationships between system configuration and measurable parameters.			
c) To the extent possible, graphics portray system/component/process status through the use of color, shading, or similar coding techniques.			
d) Coding techniques are consistently applied across the expert system.			
e) The guideline of Sections 5.1.8 "Iconic Interaction", 5.2.6 "Graphics Entry", and 5.3.8 "Data Display (Graphics)" apply to expert systems graphic interfaces.			
5.5.4.3 Off-line printing.			
a) The expert system has access to an off-line printer to allow the user to request hardcopy of screen displays, summaries of extended consultations, lists of rules/facts invoked during a consultation.			

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Checklist	YES	NO	N/A
b) The printer may be used as an alternative display device to free up the primary workstation.			
5.5.5 Certainty factors.			
5.5.5.1 Weighting certainty factors.			
a) Certainty factors reflect a weighted combination of probabilistic and cost-benefit judgments.			
b) Cost-benefit judgments are based on a formal weighting scheme that reflects the relative priorities for different classes of failures.			
c) The rationale underlying the weighting is explicitly encoded.			
5.5.5.2 Representing certainty factors.			
a) The rule set for an expert system is capable of representing certainty factors to the user.			
b) Certainty factors may be contained in the data, in one or more rules, or both.			
c) Certainty factors are represented as a decimal number from -1 to +1, with -1 indicating absolute certainty that a fact is not true, and +1 indicating absolute certainty that a fact is true.			
d) Certainty factors displayed to the user reflects the cumulative certainty for all elements of the conclusion being drawn.			
e) In addition to numerical values of certainty, the system is capable of providing some indication of rationale underlying the uncertainty, such as conditions when the rule was invalid.			

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Checklist	YES	NO	N/A
5.5.6 Explanation facilities.			
a) The expert system is capable of explaining its behavior, problem solutions, and knowledge.			
b) At any point during a consultation, the expert system is capable of displaying the rule currently being invoked.			
c) The expert system automatically records all rules invoked during a consultation.			
d) Following a consultation, the explanation facility is capable of recalling each invoked rule and associating it with a specific event to explain the rationale for the event.			
e) The explanation facility is able to search the knowledge base to locate rules or items of knowledge in response to specific inquiries from the user, to alert the user when a problem is beyond its current capabilities, and instruct the user as to what additional knowledge or rules would be required to complete the transaction.			
f) The expert system is able to respond to user requests to clarify or restate questions and assertions.			
g) The system is capable of displaying both rule-based and descriptive explanations, as requested by the user.			
h) At any point during a transaction, the expert system is able to explain which problem solving strategy is being employed, why a particular strategy was selected, and the current status of the application.			
5.5.6.1 Language/style.			
a) The presentation of information to explain or justify the behavior or knowledge of the expert system is consistent in content and format with the cognitive strategies and mental models employed by the user, particularly when the user and the expert system are independently working the same problem.			
b) At a minimum, the explanation facility employs the same nomenclature, abbreviations and acronyms for system elements as those employed by the user.			

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Checklist	YES	NO	N/A
c) The system is capable of emulating a degree of "self-awareness" by portraying, via the explanation facility, the knowledge it contains concerning the application, relevance and validity of rules and knowledge (facts) contained in its knowledge base.			
d) Explanation facility knowledge includes an understanding of the strategies and processes by which rules and facts are applied.			
e) The guidelines of Section 5.3.6 "Text [display]" are applied to explanation facilities design.			
5.5.6.2 Strategy explantion. At any point during a transaction, the expert system is able to explain which problem solving strategy is being employed, why a particular strategy was selected, and the current status of the application.			
5.5.6.3 Relation to rules and knowledge base.			
a) Rules are represented explicitly in the knowledge base and encoded in such a manner that it is accessible to the explanation facility and can be translated for human understanding.			
b) The content and detail of a rule's explanation/justification are consistent with the classification of the rule.			
c) For most systems, rules may be assigned to one of the following classes: identification rules; causal rules; world fact rules; domain fact rules.			
d) Rule exceptions are explicitly contained in the knowledge base and are available to the user as part of the explanation facility.			
e) The explanation facility has access to the rationale by which the hypotheses in a rule's premise were ordered.			
f) The rationale for ordering hypotheses is explicitly represented for the following classes of hypotheses: hypotheses related to personnel health and safety; hypotheses related to mission success, mission-critical equipment or mission-critical data; hypotheses related to nonmission-critical equipment or data; hypotheses related to mission efficiency and economics.			

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Checklist	YES	NO	N/A
5.5.6.4 Levels of explanation. a) The level of detail of information presented as part of an explanation or justification is under the control of the user. b) The user is able to specify three levels of detail: rules only, brief explanations and detailed explanations. c) Control of the explanation facility is designed such that the user may specify the level of detail as a default option at the beginning of a transaction. d) For any individual explanation, the user is able to request greater or lesser detail. e) Systems employing means-ends analysis as an element of the control strategy provides: 1) a description of the current state 2) a description of the goal state 3) a description of the difference between the current state and the goal state 4) descriptions of all candidate operators (rules), including the type and amount of difference they eliminate 5) a description of the strategies for transforming the current state or revising the goal state. 5.5.6.5 Representing reasoning. When representing its reasoning process to the user, the expert system is capable of describing how well the observed data support each hypothesis under consideration and how well each hypothesis under consideration account for the observed data.			

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Checklist	YES	NO	N/A
5.6 Data communication.			
5.6.1 General.			
5.6.1.1 User control/procedures.			
a) Data transmission functions are integrated with other information handling functions within a system.			
b) Procedures for preparing, sending and receiving messages are consistent between transactions and other information handling tasks.			
c) Data transmission procedures are designed to minimize memory load on the user and to minimize required user actions.			
d) Both sending and receiving messages is accomplished by explicit user action.			
e) Users are provided flexible control of data transmission, in terms of what, when and where data are transmitted.			
f) Users are able to interrupt message preparation, review, or disposition, and resumption is from the point of interruption.			
5.6.1.2 Wording and message content.			
a) Functional task oriented wording is used for terms in data transmission.			
b) Transmitted data is annotated with any alarm/alert conditions, priority indicators, or other significant information.			

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Checklist	YES	NO	N/A
5.6.2 Message preparation.			
5.6.2.1 Procedures.			
a) Procedures for composing messages follow the general data entry and editing procedures presented in Section 5.3 "Data Entry" of this handbook.			
b) Users do not have to learn procedures for entering message data that are different from general data entry.			
5.6.2.2 User control.			
a) Users are provided means to specify data to be transmitted and are able to incorporate existing file data in messages.			
b) Users are able to prepare and transmit messages of any length.			
c) Users are able to save draft messages during preparation, or upon completion.			
d) When messages must be transmitted following data change, the user confirms that the data are ready to be transmitted.			
5.6.2.3 Format.			
a) Unless a need exists for a specific message format, users are able to compose and transmit messages with a format of their own design, and to compose and transmit messages as unformatted text.			
b) When messages must conform to defined formats and standards, preformatted forms are available to users.			
c) Where possible, the system provides automatic message/text formatting for optional use.			
d) In forms preparation for transmission, users are able to enter, review, and edit data on any display organized with labeled fields.			
e) Users are able to enter, review, and change tabular or graphic data in customary formats; e.g., row/columns.			

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Checklist	YES	NO	N/A
5.6.3 Data transmission.			
5.6.3.1 Addressing messages.			
5.6.3.1.1 User control.			
a) Users are able to specify destinations where data will be transmitted by system users, other work stations, terminals, or users of other systems.			
b) Users are able to edit the address fields in the header of a message being prepared for transmission.			
5.6.3.1.2 Format.			
a) A basic set of header fields (DATE, TO, FROM, COPIES, TIME, "etc." that can be interpreted by all systems to which messages will be sent) is provided.			
b) Prompting is used to guide the user in specifying the address for a message.			
c) The address of a recipient occurs only once in a message.			
5.6.3.1.3 Directories/distribution lists.			
a) Address directories are provided in which users are able to search address directories by specifying a complete or partial name, or other address information and are able to select addresses without reentering the information.			
b) Users are able to define names for commonly used addresses, to save those in a file, and to address messages by name.			
c) Users are provided with information about distribution lists on which they are included, and lists they are authorized to use.			
c) Users are able to create and modify their own lists, and within a distribution list, users are able to include other distribution lists as well as individual addresses.			
d) Where coordinated review of messages by several recipients is required, the sender is able to specify a serial distribution so that a message will be passed from one recipient to the next.			

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Checklist	YES	NO	N/A
5.6.3.1.4 Validation and error correction.			
a) Computer checks for address accuracy are provided.			
b) Users are required to correct mistakes before initiating message transmission.			
c) Users are able to print copies of transmitted messages.			
5.6.3.2 Initiating transmission.			
5.6.3.2.1 System control.			
a) When standard messages must be transmitted means are provided to initiate transmission automatically.			
b) Automatic queuing of outgoing message is provided to reduce user involvement in routine transmission.			
5.6.3.2.2 User control.			
a) Users are able to initiate data transmission directly, by entering an explicit SEND command.			
b) Users are able to choose whether to transmit a displayed version of a message, or to transmit directly from stored files.			
c) Users are able to assign priority to messages, and to defer the transmission of messages to a specific date, time, or by later action.			
d) Message transmission is provided with annotations such as "RECEIPT REPLY REQUESTED", under sender's control.			
e) Senders are able to cancel or abort a transmission that has not been completed or initiated.			
5.6.3.2.3 Data display.			
a) Status information concerning the identity of other system users currently on-line is available.			
b) When a message is sent, the computer appends the sender's address, and the date and time of message creation and transmission.			

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Checklist	YES	NO	N/A
5.6.3.3 Controlling transmission.			
5.6.3.3.1 System control.			
a) Transmitted data are protected automatically with parity checks to detect and correct any errors that may occur.			
b) Automatic feedback is provided for data transmission, confirming that messages have been sent, or indicating transmission failures.			
c) Only one copy of any message is transmitted to an individual addressee.			
5.6.3.3.2 User control.			
a) Users are able to specify what feedback will be provided for message transmission, and to request specific feedback for particular messages.			
b) Users are able to recall or abort transmissions after initiation, if messages have not been received.			
c) When required, automatic record keeping is provided.			
5.6.3.4 Transmission failure.			
a) In the event of transmission failure, automatic queuing is provided to preserve outgoing messages.			
b) If message transmission fails, automatic storage of undelivered messages is provided, and the sender is notified. Notification includes an explanation of the failure.			

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Checklist	YES	NO	N/A
5.6.4 Message receipt.			
5.6.4.1 System control.			
a) Incoming messages are automatically queued by time of receipt, message priority, or user specification, pending subsequent review and disposition by the user.			
b) Logs of messages received and sent are automatically maintained by the system.			
5.6.4.2 User control.			
a) Users are able to specify data that may be received, by specifying receipt priority or other means, and are able to choose what device will receive messages.			
b) Users are able to specify "filters" based on message source, priority, type, or content, that will control notification for incoming messages.			
c) Users are able to assign their own names and other descriptors to received messages.			
d) Users are able to discard unwanted messages without filing.			
5.6.4.3 User review of messages.			
a) Means are provided for users to specify message summary listing orders.			
b) Unless required for security or other procedure, means for review of messages are provided without requiring user disposition .			
c) Users are able to review summary information about the type, source, and priority of queued incoming messages.			
d) Display designs for received messages are consistent with general data display guidelines presented in Section 5.3.6 "Data Display - Text".			
e) Users are able to annotate reviewed messages. Annotations are displayed and are distinct from the message itself.			
f) An indication of message size is included in message summaries and at the beginning of each incoming message.			

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Checklist	YES	NO	N/A
5.6.4.4 Format. a) If data transmission arrives in an incompatible format, recipients are advised. b) Incompatible formats do not destroy the incoming message or any ongoing transactions of the receiver. 5.6.4.5 Data display. a) Users are notified at log-on of any data transmissions received since last use of the system. b) Notification of arriving messages do not interfere with a users ongoing tasks. c) Priority of received messages is indicated in applications where incoming messages will have different degrees of urgency, i.e., different implications for action. 5.6.4.6 Reply. When replying to a message, the appropriate address(es) is provided automatically.			

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Checklist	YES	NO	N/A
5.7 Data protection.			
5.7.1 General.			
a) Clear and consistent procedures are provided for different types of transactions, particularly those involving data entry, change, deletion, and error correction.			
b) The system deals appropriately with all possible user errors and random inputs, without introducing unwanted data change.			
5.7.1.1 System control.			
a) Automatic measures to minimize data loss from computer failure is provided.			
b) Whenever possible, automated measures for data security is provided, relying on computer capabilities rather than on humans.			
c) When a proposed user action will interrupt a current transaction sequence, automatic means to prevent data loss is provided.			
d) Where potential data loss cannot be prevented, the user is warned, and the action is not implemented without user confirmation.			
e) When function keys or other devices are not needed for a transaction type and when they may have destructive effects, they are disabled under software control to avoid activation.			
f) Automatic defaults, if provided for control entries, protects against data loss, and does not contribute to the risk of data loss.			
5.7.1.2 User actions.			
a) Data are protected from inadvertent loss caused by the actions of other users.			
b)Users are able to designate their own files and data as protected from the actions or access of others.			
c) Frequent or urgent actions are easy to perform, potentially destructive actions are sufficiently difficult to require additional user attention.			
d) Unless real-time computer monitoring is performed, data is changed only as a result of explicit user actions.			

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Checklist	YES	NO	N/A
e) Explicit action to select destructive modes is required.			
f) Users are required to take an explicit extra action to CONFIRM a potentially destructive or critical control entry before it is accepted by the computer for execution.			
g) A CONFIRM action is distinctively labeled.			
h) Users are required to wait for computer prompting to CONFIRM so that the confirmation will constitute a second, separate action.			
i) Users are able to UNDO an immediately preceding control action that may have caused an unintended data loss.			
j) Users are not able to change protected or controlled data.			
5.7.1.3 Simulation and training.			
a) When simulated data are used in conjunction with system functions, actual, unsimulated data is protected.			
b) Operational system use is clearly indicated and distinguishable from simulated operations.			
5.7.1.4 Data display.			
a) Computer logic that will generate messages or alarm signals is provided to warn users of potential threats to data security.			
b) A continuous indication of the current operational mode is displayed, particularly when transactions might result in data loss.			
c) For conditions which may require special user attention to protect against data loss, an explicit alarm or warning message is provided to prompt appropriate user action.			

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Checklist	YES	NO	N/A
5.7.2 User authentication. 5.7.2.1 Unauthorized access. A limit on the number and rate of unsuccessful LOG-ON attempts is imposed to provide a margin for user error, while protecting the system from persistent attempts at illegitimate access. 5.7.2.2 Identification and passwords. a) LOG-ON processes are designed to provide prompts for all user entries, including passwords and other data required to confirm user identity and to authorize data access privileges. b) When system security requires more stringent user identification than is provided by password entry, auxiliary tests may be used that authenticate user identity, but does not impose impractical demands on users memory. c) Users are able to choose or change their own passwords. d) Where data protection is critical, user selected passwords are tested against a list of common passwords or commonly known user data. e) When a password must be entered by a user, password entry is private; password entries are not displayed, but display echoes (such as "*") for each keystroke is provided. f) Unless a specified period of inactivity has expired or under special security procedures, whatever data access/change privileges are authorized after identity, authentication continues throughout a work session.			

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Checklist	YES	NO	N/A
5.7.3 Data access.			
5.7.3.1 Classified data protection.			
a) When displayed data are classified for security purposes, a prominent indication of security classification is presented in each display.			
b) When classified information is displayed, some rapid means for suppressing a display is provided.			
c) Procedures to control access to printed or printing data is provided rather than prohibiting the printing of classified information.			
d) When sensitive data may be exposed to unauthorized access, a capability for encrypting data is provided.			
e) Data encryption is easily reversible.			
5.7.3.2 Record/log keeping.			
a) The computer automatically keeps records/logs of data access.			
b) Users are not relied on to take critical record keeping actions.			
c) Transaction records and logs are stamped with user identifiers, time, and date.			
d) Provisions are made to control requests for records and logs of data transactions with classified material.			
e) Users are informed concerning the nature and purpose of automated recording of individual actions.			
f) When multiple users review, enter, or modify data in a system, they are able to review and browse data changes or entries made by other users.			
5.7.3.3 Data preservation.			
a) When protection of displayed data is essential, the computer maintains control over the display and does not permit a user to change "read-only" data.			
b) A "read-only" status is indicated for users not authorized to change displayed data.			

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Checklist	YES	NO	N/A
c) Provisions are made to prevent accidental activation of potentially destructive control actions.			
d) When required, display formatting features, such as field labels and delimiters, are protected from change by users.			
e) If a complete file is to be deleted, sufficient information, is displayed to verify the file for deletion.			
f) Users are required to confirm destructive entries.			
g) The prompt for a CONFIRM action warns users explicitly of any possible data loss.			
h) An explicitly labeled CONFIRM function key, different from the ENTER key is provided for user confirmation of critical control and data entries.			
i) Data loss at LOG-OFF is avoided by a check on pending transactions and display of an advisory message requesting user confirmation.			
j) When two or more users have simultaneous read access or data processing results from multiple user-computer interfaces, the operation by one person does not interfere with the operations of another person, unless mission survival may be contingent upon the preemption.			
k) Provisions are made so that the preempted user can resume operations at the point of interference, without information loss.			
5.7.3.4 Data entry/change. Procedures for data entry and change follow guidelines presented in Sections 5.2 "Data Entry", 5.1 "Dialogs/Interaction Control, and 5.3 "Data Display".			

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Checklist	YES	NO	N/A
5.7.4 Classified data transmission.			
5.7.4.1 System control.			
a) Measures provided to protect data during transmission are applied automatically, without the need for user action.			
b) A copy of any transmitted message is automatically saved until correct receipt has been confirmed.			
c) As necessary, automatic queuing of incoming messages are provided to ensure they do not disrupt current classified information handling tasks.			
5.7.4.2 User actions.			
a) When a user must confirm the identity of a message source, computer aids such as computer-generated confirmation codes are provided for that purpose.			
b) When human judgment may be required to determine whether data are appropriate for transmission, users or a system administrator are provided means to review outgoing messages and confirm release before transmission.			

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