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JUN 63 A J MCKNIGHT, P J BUTLER DA-44-188-ARO-2

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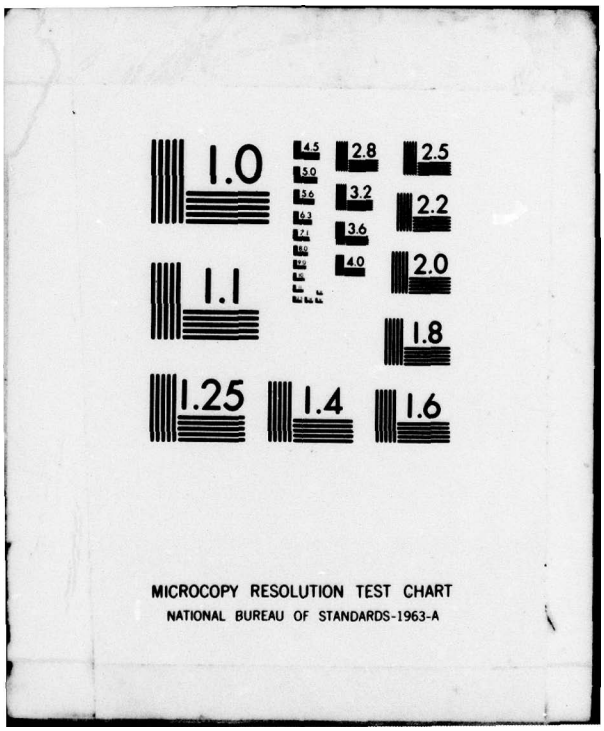
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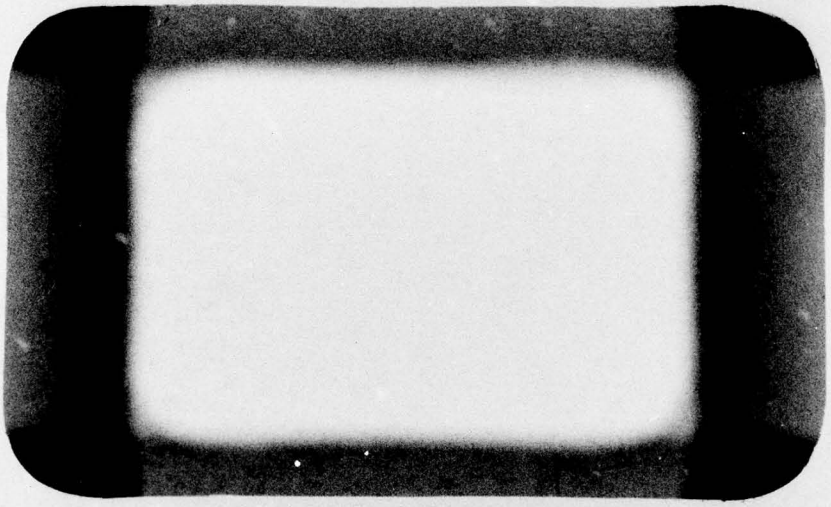

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This document contains two papers--one of which proposes requirements relating to the nature of personnel and training information to be provided concurrently with materiel development, and the other which describes the bases upon which the proposed requirements were established.

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Staff Paper

REQUIREMENTS FOR PERSONNEL AND TRAINING INFORMATION

by

A. James McKnight and Patrick J. Butler

This Staff Paper has been prepared for dissemination within HumRRO for purposes of information or coordination internal to the organization. It does not necessarily represent official opinion or policy of either the Human Resources Research Office or the Department of the Army.

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The George Washington University
HUMAN RESOURCES RESEARCH OFFICE
operating under contract with
THE DEPARTMENT OF THE ARMY

PREFACE

This Staff Paper consists of two documents which were prepared at the request of the Human Factors and Operations Research Division, ARO, OCRD, and submitted to that office in June 1963.

The two documents are:

a. Requirements for Personnel and Training Information, which proposes requirements relating to the nature of personnel and training information to be furnished concurrent with material development; and,

b. Identification of Personnel and Training Information Requirements, which describes the bases upon which the proposed requirements were established and outlines further information needs.

These documents were the products of a joint APRO-HumRRO effort launched by a letter from Chief, Human Factors Research Division, ARO, OCRD, on 7 March 1962. The documents were written by Dr. A. James McKnight and Mr. Patrick J. Butler of HumRRO with the assistance of Dr. Robert Boldt and Dr. Martin Wiskoff of the U. S. Army Personnel Research Office.

HumRRO participation took place under Task SYSTEM.

The primary purposes of the belated publication of this report are (1) to provide a more formal documentation of our response to the HFORD request, and (2) to make it more widely available within HumRRO.

IDENTIFICATION OF PERSONNEL AND TRAINING INFORMATION REQUIREMENTS

Military Problem

The Army's ever-expanding inventory of complex weapon systems has created an increased need for highly skilled personnel to man them. The situation is further complicated by the fact that the characteristics of the available manpower pool have not substantially changed to meet new system demands. Therefore the task of providing proficient personnel, capable of operating and maintaining new equipment as it is delivered, has become a formidable one.

Critical to the availability of qualified personnel is the timely provision of accurate information concerning the personnel and training requirements imposed by each new item of materiel. Such information is needed for planning and development of personnel and training products including duty positions, MOS, personnel qualifications, training programs, training device requirements, etc. The degree to which this information has been available has varied considerably. Access to this information is likely to become more difficult due to the increasing complexity of materiel and the administrative separation of technical schools from Army materiel development agencies.

Research Problem

Early in 1962 the Human Factors Research Division of the Office of Chief of Research and Development requested the Army Personnel Research Office and the Human Resources Research Office to study means by which needs for personnel and training information could be satisfied. Discussions were held with representatives of the Office of Personnel Operations, Combat Developments Command, Office of Civilian Personnel, the Continental Army Command, and individual Army schools in order to identify the nature of information needed. Documents concerning Army organization, responsibilities, development processes, etc., were studied to establish the framework in which information must be provided. Specifications, standards, research reports, and so on were surveyed to identify techniques for derivation and distribution of needed information.

The first effort was the preparation of requirements relating to the nature and derivation of personnel and training information which must be obtained from any materiel development activity. These requirements are contained in the accompanying document. The following discussion offers explanation of those requirements whose rationale is not readily apparent from the description of the requirements.

Nature of Information

The development of personnel and training products demands precise information concerning the human capabilities, i.e., knowledges, coordinations, aptitudes, and physical characteristics, required for successful system performance.

Task Analysis. Determination of required capabilities must be based upon the detailed analysis of task performances involved in operation and maintenance of materiel. While the highly detailed analysis of tasks forms a necessary tool in the accurate determination of personnel and training requirements, it does not itself directly provide the most useful information for the various personnel and training activities.

First, mere descriptions of task elements do not define the human capabilities which enable personnel to perform them. For example, the technical knowledges required to make certain decisions will not be apparent from a description of the operations involved. Determining the appropriate technical knowledges, like determining other human capabilities, is a highly technical process demanding a thorough understanding of total system.

Secondly, to detect a specific requirement, such as a critical physical or safety requirement, may necessitate the detailed analysis of large volumes of performance data (see Section II-2-b). For each personnel activity to scrutinize such a volume of information in the preparation of every new MOS would be prohibitive. However, such requirements will generally be easily identified during the course of a detailed analysis of tasks, provided such analysis is performed by technically competent human factors personnel. Information concerning these requirements, provided it is substantiated by descriptions or examples of tasks posing them, should be adequate for personnel and training development.

By confining the reporting of basic task analytic data to special needs (Section II-3-c), the developer or contractor is permitted greater flexibility in (1) adapting the analysis format to its manifold uses in human engineering, design of tools and printed job aids, preparation of maintenance allocation charts, etc., and (2) the means he uses to record and update analytic information, e.g., use of automatic data processing equipment.

Some description of tasks will, of course, be necessary for a variety of personnel and training purposes. However, the highly detailed "task and skill analysis" is considered more appropriately a tool than a product.

Personnel and Training Products. While personnel and training information provided by the system developer should describe the human capabilities which the system will demand, it has not been considered appropriate for such information to specify the actual nature of personnel or training products themselves, e.g., length of training and occupational specialties. Beyond lacking the mission, the developer does not generally possess the technical capability to make such determinations or the necessary access to internal considerations such as doctrine, available manpower and economic resources, and on-going activities.

It is recognized that information concerning one personnel or training product is frequently required for the development of another, e.g., the need to know length of training in establishing MOS requirements. While the attempt has been made to exploit the developer's central system development role for communication of such information (Section II-1-a-(3)), the primary responsibility for this coordination rests with the affected personnel and training activities.

Consolidation

It is important that determination of all personnel and training requirements be consolidated under a single analysis of tasks and required capabilities. It is equally important that this consolidation encompass all other activities requiring a similar analysis. One such activity is the preparation of printed job supports, e.g., technical manuals, which contain that information needed for performance of tasks. Another is the breakdown of maintenance operations and the consideration given to required skills in the allocation of maintenance functions.[1] Finally, there is the general consideration of tasks and capabilities in design of equipment for improved operability, maintainability, and reliability.

The need for consolidating these activities is critical. First, the substantial cost of securing common source data necessitates avoidance of duplication. It is considered likely that if the determination and reporting of all personnel-related requirements were adequately consolidated, and maximum use made of existing reporting mechanisms, personnel and training information could be obtained without substantial increase over present cost. Naturally, this would necessitate initial inclusion of personnel and training information requirements in overall technical requirements in order that the contractor may incorporate the necessary consolidation in his proposals and cost estimates.

The second reason for consolidation is the need for all personnel-related activities to be directed toward the same sets of tasks and human characteristics if they are to be properly coordinated. For example, the content of technical manuals and training programs must be based upon the same information needs as derived from task performance requirements.

Finally, selecting the optimum performance requirements (e.g., troubleshooting method), or required characteristics (e.g., technical knowledges) will frequently require the trade off of more than one personnel-related consideration, e.g., balancing the desire to combine duty positions with the need to keep each position homogeneous with respect to training and selection requirements. Assessment of trade offs requires simultaneous consideration of all factors involved; this cannot occur except under consolidated analysis.

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[1] Maintenance of supplies and equipment: maintenance planning, allocation, and coordination, AR 750-6, 10 June 1957.

Level of Detail

Information requirements vary as to the level of detail, depending upon the nature of the personnel and training activity and the stage of materiel development. However, two general types of information seem to be called for. One consists of a rather general summary of the system and its requirements, for purposes of overall familiarization, planning, and coordination (Section II-1). Such information could be widely distributed to personnel-related activities as part of materiel status, progress, feasibility, or other standard reports. While information of this general nature is now provided upon occasion, there is a need to assure systematic preparation and standard distribution of such information. Maximum use has been made of existing technical reporting mechanisms (Section II-1-b) in order to avoid adding additional data milestones to an already complex network and to gear the volume and schedule of personnel and training information to the size and rate of progress of the system under development.

Those particular personnel and training activities responsible for selection, establishing qualifications, or training of personnel for a particular system require more detailed information (Section II-2) for the development of their respective products. The primary consumer of this information will, of course, be user and support training activities. Detailed information is intended to augment rather than replace new equipment training (NET) as a means for initial transfer of technical knowledge. While NET serves a necessary function, the increasing volume and complexity of materiel has created difficulties in (1) securing higher level technical personnel from existing operational systems for NET, (2) preparation and administration of NET in time to meet reduced lead time requirements for training development, (3) assuring total capture of the large volume of technical information, (4) translating technical information into complete and efficient training curricula, and (5) assuring long-term retention of NET personnel for training development in the face of equipment test requirements and world-wide manpower needs.

Both the availability of system information and the need for personnel and training information will become increasingly detailed as design of both materiel and personnel components of the system proceed from broad concept to detailed design stages. The continuous nature of system design refinement makes it unrealistic to establish fixed information requirements for all systems (beyond the requirement for assuring that all information is up-to-date). Table 1 provides an indication of the type of information which would typically prevail at each major system development stage as well as the personnel and training activities for which this information is needed.

Derivation of Information

The purpose of the proposed requirement is to establish standards for personnel and training information, and not to provide guidance or techniques for its generation. Lacking an objective criterion, the quality of personnel and training information, like that of a medical diagnosis, can only be assured by specifying the bases upon which it is

derived. The proposed requirements of Section III identify those system considerations which form the logical basis for determination of needed human capabilities. The analytic approach depicted graphically in Figure 1 is based upon accepted standards for the systematic determination of personnel and training requirements and is consonant with CONARC training policy.[1] While the nature of information involved in the analytic process changes continuously throughout system development, the process itself remains essentially the same and is, for this reason, treated in a separate section.

Implementation Needs

The initial step in the acquisition of personnel and training information is the establishment of information requirements. Were the proposed requirements to prove acceptable, implementation would necessitate the additional preparation of guidance documents and contractor specifications. The purpose of guidance documents would be to identify procedures for in-house preparation of personnel and training information as well as to supply standards for assuring the quality of information procured from a contractor. Such a document would draw from state-of-the-arts analytic techniques, data formats, information flow, and so forth. Specifications would detail the nature and derivation of information to be provided by the contractor and could be wholly or partially referenced in Technical Requirements, Requests for Proposals, and contracts.

Additional Needs

Identification of human capabilities required by new materiel forms the keystone of effective personnel and training information flow. However, there are other critical elements. After the materiel-generated requirements are obtained from the developer, there remains the need for exchange of other personnel-related information among the separate personnel and training activities. This would include such information as length of training, training device requirements, and so on. Both the U.S. Continental Army Command and the Office of Personnel Operations are currently engaged in efforts to define overall information requirements.

The need for identification of personnel and training requirements continues after the system becomes operational owing to (1) apparent inadequacies in personnel training, selection, classification, staffing, etc., (2) changes in system mission or environment, or (3) subsequent modifications in equipment design. Individual personnel and training agencies must establish their own feedback mechanisms to keep abreast of changing conditions. However, it will be necessary to maintain a central analysis of the system's evolving needs throughout its operation just as it was during system development. Military requirements, specifications, etc., must be prepared for producers as well as developers of materiel.

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[1] Principles of curriculum development are described in Annex T to USCONARC Training Directive, April 1962.

TABLE 1

Representative Schedule of Personnel and Training Information Requirements and Development Activities

PHASE OF MATERIEL DEVELOPMENT	PERSONNEL AND TRAINING INFORMATION REQUIREMENT (AND RESPONSIBLE AGENCY)	PERSONNEL AND TRAINING DEVELOPMENT ACTIVITY
QMDO		
Preparation of research, technical, and state-of-the-arts reports.	Include summary of general human functions and required capabilities for any materiel undergoing research (AMC-Contractor).	Assess personnel and training feasibility.
Preparation of QMR.	Assure above summary is available to Personnel and Training Activities (AMC).	Provide guidance to CDC on personnel and training implications of proposed materiel.
Preparation of Total Feasibility Studies	Include updated summary of general human functions and required capabilities for particular materiel item (DCSOPS).	Prepare estimates of personnel and training needs; determine effect upon personnel and training resources.
Preparation of Technical Characteristics.	Include requirements for acquisition of personnel and training information (AMC).	Provide guidance to AMC on personnel and training information requirements. Update planning.
Request for proposal or quotation.	Include general contractor requirements for personnel and training information (AMC).	Provide guidance on detailed information needs.

TABLE 1 (Cont'd)

PHASE OF MATERIEL DEVELOPMENT	PERSONNEL AND TRAINING INFORMATION REQUIREMENT (AND RESPONSIBLE AGENCY)	PERSONNEL AND TRAINING DEVELOPMENT ACTIVITY
Contractor Proposal.	Include proposal for nature, derivation and distribution of personnel and training information (Contractor).	Provide guidance to AMC evaluation of personnel and training information proposals where requested.
Preparation of Technical Development Plan.	Include funding requirements for personnel and training information. Furnish schedule of major milestones to Personnel and Training activities (AMC).	Planning and budget development of personnel and training products.
Development Contract Award.	Include detailed contractor requirements for personnel and training information (AMC).	
Start of engineering design.	Identify human tasks; determine preliminary duty positions; refine earlier estimates of required capabilities (AMC-Contractor).	Develop advance TOE's, tentative MOS, training plan; identifying long lead-time training device requirements.
Engineering design freeze.	Begin detailed analysis of tasks and required capabilities; update earlier summary estimates; begin transfer of detailed technical information to training activities (AMC-Contractor).	Approved tentative MOS and prepare draft MOS; establish NET requirements; begin documentation of resident training; begin long lead-time training device engineering design.

TABLE 1 (Cont'd)

PHASE OF MATERIEL DEVELOPMENT	PERSONNEL AND TRAINING INFORMATION REQUIREMENT (AND RESPONSIBLE AGENCY)	PERSONNEL AND TRAINING DEVELOPMENT ACTIVITY
Preparation of coordinated test plan.	Include plan for evaluation of personnel and training information (AMC).	
Engineer-service tests.	Revise personnel and training information on the basis of test results (AMC-Contractor).	Modify personnel and training products.
Type classification and release of R&D design.	Complete transfer of detailed technical information (AMC-Contractor).	Approve MOS; approve POI and continue training documentation; approve training device design; draft TOE's.
	START PRODUCTION PHASE	
Production contract award.	Include requirements for further updating of personnel and training information (DCSLOG).	Draft quantitative personnel estimates; start training device procurement; approve TOE's.
Delivery of first production item.	Update personnel and training information in response to production changes (DCSLOG-Contractor).	Begin receipt of training devices; start resident individual training.
Army readiness date	(As above)	Complete resident and unit training. Approved quantitative personnel estimates.

TABLE 1 (Cont'd)

PHASE OF MATERIEL DEVELOPMENT	PERSONNEL AND TRAINING INFORMATION REQUIREMENT (AND RESPONSIBLE AGENCY)	PERSONNEL AND TRAINING DEVELOPMENT ACTIVITY
Field deployment and operation.	Update personnel and training information in response to field experience and/or equipment design modifications (DCSLOG).	Continued modification and refinement of personnel and training products.

Derivation of Personnel and Training Information

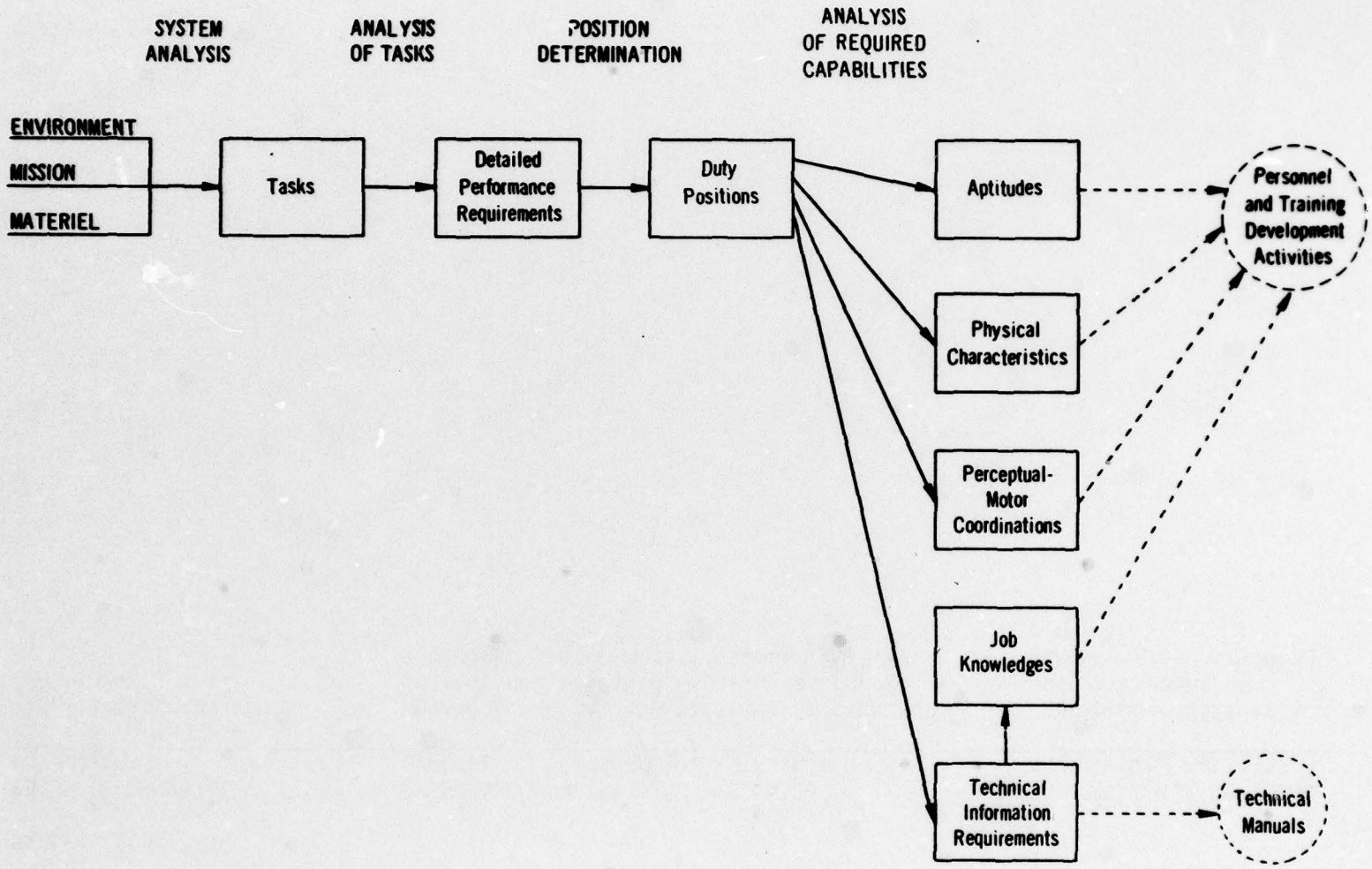

Figure 1

REQUIREMENTS FOR
PERSONNEL AND TRAINING INFORMATION

SECTION I

GENERAL

1. Purpose

This document establishes requirements relative to the nature and derivation of personnel and training information to be furnished concurrent with the development of new Army materiel.

2. Background

The availability of qualified personnel to operate and maintain new Army materiel as it becomes operational is dependent upon the timely flow of accurate information concerning personnel and training requirements throughout the system development cycle. Such information is required to permit affected Personnel and Training agencies to:

a. Undertake planning and development of appropriate products in sufficient time to meet Army operational readiness requirements.

b. Identify those requirements which either exceed, or fail to utilize adequately, available personnel resources.

3. Objective

The objective of personnel and training information is to identify those human capabilities required for effective system operation and support. In accordance with this objective, the following requirements for personnel and training information have been established:

a. Required capabilities must be identified in sufficient detail to permit personnel normally responsible for the development of personnel and training products to carry out these activities without recourse to additional system information or analysis.

b. All human capabilities required by a system must be identified to the level of detail permitted by the system information available during each stage of development.

c. Each required human capability must fulfill a clearly identifiable system need.

d. Personnel and training information will be restricted to identifying capabilities imposed by the system and will not attempt to specify the actual nature of personnel and training products (e.g., MOS, course length, etc.).

4. Personnel and Training Activities

For the purpose of this document, personnel and training activities will consist of the following organizations and their designated sub-activities:

a. Combat Developments Command (CDC) for all matters pertaining to preparation of Tables of Organization and Equipment (TOE's).

b. Continental Army Command (CONARC) for all matters pertaining to training.

c. Office of Civilian Personnel (OCP) for all matters pertaining to civilian personnel.

d. Office of Personnel Operations (OPO) for all matters pertaining to preparation of Military Occupation Specialties (MOS) and qualifications.

5. Consolidation

a. The determination of all personnel and training requirements must be consolidated within a single activity since all such requirements are based upon the human role in achieving system performance. This consolidation must further embrace other personnel-related development activities requiring identification of this role, including:

(1) Preparation of printed job supports, e.g., technical manuals.

(2) Allocation of maintenance responsibility, e.g., maintenance allocation charts.

(3) Determination of equipment maintainability and operability requirements.

b. Consolidation of personnel-related efforts is necessary in order to:

(1) Attain maximum coordination of interrelated system products.

(2) Minimize duplication in securing common source data.

(3) Achieve optimum tradeoffs in selecting among alternative combinations of requirements.

6. Concurrency

Personnel and training information must be provided concurrent with system development, beginning with the earliest formulation of materiel requirements and continuing until the system is developed.

This information must be constantly updated in response to design refinements and modifications so as to reflect at all times the current state of system needs. Such an early and continuous information flow is needed to permit personnel and training agencies to:

a. Expedite planning and development of their associated products in accordance with reduced lead time and operational readiness requirements.

b. Provide valid inputs to system design, while it is still malleable, through normal in-process reviews, specific recommendations, etc.

SECTION II

INFORMATION REQUIREMENTS

This section establishes requirements relative to the nature of personnel and training information. Two types of information are called for, summary and detailed. The purpose of summary information is to provide an up-to-date inventory of required capabilities to permit planning and coordination of personnel and training development. Detailed information is intended to provide all the specific system information needed for actual development of personnel and training products.

1. Summary Information

A summary of personnel and training requirements will be maintained throughout the research and development cycle of each major item of materiel.

a. Nature of Information

The volume of summary information will vary with the complexity of the materiel item and the amount of system design data available at a given time. Information in the following categories will be provided as comprehensively and as accurately as possible.

(1) System description--A brief description of the materiel involved, its mission or intended use, and the conditions under which it will be utilized. This will include the following characteristics as they are established:

(a) Principal mission characteristics.

(b) Organizational, operational, and support concepts and plans.

(c) Prime and support equipment characteristics.

(d) Schedule of the major milestones in system development.

(2) Personnel and training requirements--To be provided separately for each operator and maintenance duty position, including separate skill levels where appropriate.

(a) Manning--Number of personnel required.

(b) Tasks

1 General nature of tasks, to include both individual and group tasks.

2 General proficiency levels, including critical speed, accuracy, or reliability requirements.

3 Nature and content of printed job supports, including technical manuals, handbooks, information storage-retrieval equipment, etc.

(c) Knowledges--The general nature of the knowledges required to perform tasks, including operator and maintenance procedures, technical system data, concepts and theory.

(d) Perceptual-motor coordinations--General description of those tasks involving sufficiently rapid perceptual-motor coordinations as to require practice to achieve performance standards.

(e) Type of training--Performance objectives, knowledges, and coordinations for each type of training will be identified as follows:

1 Individual--Those requiring individual instruction and practice.

2 Unit--Those involving interactions among individuals.

3 On-the-job--Those which may be acquired through experience and/or informal training on the job.

4 Readiness--Those requiring scheduled practice to sustain proficiency.

(f) Prerequisites--General nature of personnel qualifications, including:

1 Important mental abilities and aptitudes.

2 Unusual physical requirements.

3 Critical personal characteristics (e.g., judgment).

(3) Personnel and Training Developments Information

(a) Personnel and training requirements information will be modified, augmented, and reorganized as necessary to reflect all development plans and decisions of responsible personnel and training activities. Not only will this keep summary information current but it will also serve as a medium for the coordination of interrelated personnel and training development activities.

(b) The following development information will be incorporated:

1 Military organization, e.g., TOE.

2 Job specialty.

a MOS title

b Entry requirements

c MOS feeder patterns

d Skill level digit

3 Training

a Responsible schools

b Course titles and lengths

c Class schedules and quotas

b. Distribution

(1) Summary information will be routinely distributed to all personnel and training activities. Distribution to other interested activities will be made upon request.

(2) Initial distribution of summary information will occur in time to permit personnel and training activities to provide guidance in preparation of relevant portions of the QMR. This early information may be included in technological, feasibility, state-of-the-arts, QDRI, or other reports provided prior to QMR preparation.

(3) Summary information will be provided throughout materiel development by means of normal technical data, progress, or other reports. Supplements will be provided as necessary to satisfy concurrency requirements. The schedule of supplements will be regulated by:

(a) Major design modifications or refinements.

(b) Schedule of major in-process reviews.

(c) Completion of major design milestones, including approval of engineering concept, release of design characteristics, delivery of first prototype, and release of design for production.

(4) To facilitate dissemination of summary information, the inclusion of classified material will be minimized. Consideration will be given to transfer of classified material to a separate appendix.

2. Detailed Information

With the initiation of detailed materiel design, each separate personnel and training activity will be provided that specific information required for the development of its individual products. Detailed information will constitute the primary medium for transfer of technical information from the developer to personnel and training activities.

a. Personnel Information

Detailed personnel information will consist of information concerning job positions, duties, and personnel qualifications as required in the preparation of TOE's and MOS.

(1) Nature of Information

The following information will be provided for all duty positions identified in preliminary TOE's (tentative, advanced, etc.), or through liaison with the responsible personnel activity:

(a) Duties:

1 General nature of activities and responsibilities.

2 Location of activity, including maintenance echelon.

3 Major items of prime and support equipment involved.

4 Principal relation to other duty positions.

(b) Qualifications--All general personnel characteristics required for acquisition and/or application of specific job knowledges and coordinations, including the following:

1 Mental abilities

a Appropriate aptitude areas

b Other specific identifiable abilities

2 Perceptual-motor abilities (e.g., finger dexterity, etc.).

3 Critical personal characteristics, including leadership, emotional stability, attention to detail, judgment, etc.

4 Physical requirements

a Sensory (e.g., acuity)

b Motor (e.g., strength)

c Structural (e.g., height)

d Condition (e.g., endurance)

(c) Justification--Brief descriptions or examples of specific performances to support requirements for each stated qualification.

(2) Additional Information

The above information concerning duties and qualifications, when accompanied by adequate justification, should be sufficient for preparation of MOS and TOE's. However, research and staff studies conducted by various personnel activities will occasionally require additional information. Provision of additional information will be subject to the following conditions:

(a) More detailed information concerning required performances, and their underlying knowledges and coordination, as contained in detailed training information, printed job supports, and available technical data, will be supplied upon request.

(b) Requests for basic data (e.g., analysis of tasks, etc.) will be weighed against the cost of preparing and distributing such information.

(3) Distribution

The nature and schedule of distribution will be established with appropriate CDC and OPO personnel prior to the initiation of detailed design. The actual schedule will be dependent upon the adequacy of early summary information for preparation of preliminary personnel products (e.g., advanced TOE's, experimental MOS, etc.). To provide maximum precision for final TOE's and MOS, distribution will not generally occur before approval of detailed materiel design.

b. Training Information

Detailed training information will encompass all information required for documentation of training, including preparation of lesson

plans, training standards, training literature, training aids, and training device requirements.

(1) Nature of Information

The following information will be provided for each training program as identified by the responsible training activity:

(a) Task Description--General nature and critical performance standards of all tasks to include the following types:

1 Reconnaissance, planning, etc.

2 Programming, energizing, etc.

3 Operating, controlling, maneuvering, etc.

4 Loading, transporting, etc.

5 Assembling, positioning, etc.

6 Preventive and corrective maintenance

7 Monitoring, surveillance, etc.

8 Communication

9 Navigation

10 Administration, supervision, coordination

(b) Knowledges--That detailed job information which must be covered to some degree in training, including the following:

1 Identifying information, including physical characteristics and location, coding, nomenclature, etc.

2 Procedures, including operation, maintenance, communication, etc.

3 General practices, techniques, methods, etc.

4 System technical data, including design characteristics, outputs and tolerances, data flow, system equations, enemy characteristics, environmental conditions, etc.

5 Theoretical information, including fundamental laws, concepts, logical principles, theory of operation, etc.

(c) Perceptual-motor coordinations--Detailed description of all continuous perceptual-motor performances including:

1 Specific input-output relations

2 Feedbacks (e.g., control lags)

(d) Training Objectives--The level of speed, accuracy, and/or reliability of task performance which must be attained through formal training will be identified. Individual and unit training objectives will be clearly distinguished. Where possible, the level of specific knowledges needed to meet performance objectives will be identified.

(2) Distribution

(a) The nature and schedule of distribution for detailed information will be established with the appropriate training activities prior to the initiation of detailed design.

(b) In the interest of reduced lead time, detailed training information will be distributed as rapidly as possible following establishment of design for independent system components and will not be delayed for completion or approval of total system design.

(c) In accordance with consolidation requirements, appropriate portions of detailed information may be distributed through draft or other early forms of printed job aids (e.g., technical manuals), provided such does delay training development activities.

3. Preparation

Summary and detailed information will be prepared in accordance with processes described in Section III.

a. Liaison

The necessary liaison will be established and maintained with the following:

(1) Personnel and training activities for:

(a) Guidance relative to the nature and schedule of summary and detailed information requirements.

(b) Information concerning doctrine, policy, and available personnel and training resources.

(c) Plans and decisions relative to:

1 Advance and final TOE's.

2 Tentative, experimental and final MOS.

3 Training concepts, plans, POI's, etc.

(2) CDC for information relative to:

(a) Proposed materiel utilization, mission requirements, etc.

(b) Organizational, operational, support policy, doctrine, and plans.

(c) Results of operations analyses, combat development studies, etc.

b. Coordination

Where materiel research and/or development responsibility is divided among separate activities (e.g., commodity commands), the necessary coordination will be effected to assure integration of personnel and training requirements across the total system.

c. Basic Data

The data generated in the course of determining personnel and training requirements will not be routinely reported. Such data will, however, be maintained in such a way as to permit:

(1) Clarification and/or substantiation of stated requirements upon request of the affected personnel or training activities.

(2) Transfer of data among activities sharing responsibility for determination of personnel and training requirements.

d. Contracting Requirements

Where identification of personnel and training requirements is to be accomplished under contract, the cognizant contracting activity will undertake the following activities to assure that the requirements stated in this document are met.

(1) Securing Information--Provision will be made for the procurement of personnel and training information through:

(a) Inclusion of procurement requirements in:

1 Technical characteristics

2 Request for proposals or quotations

3 Contracts

(b) Evaluation of contractor proposals and capability for providing such information.

(2) Monitorship--The contractor activity will be monitored to assure compliance with requirements for preparation and distribution of personnel and training information.

(3) Liaison--Direct liaison will be arranged between the contractor and individual personnel and training activities to expedite:

(a) Provision of guidance to the contractor relative to personnel and training considerations.

(b) Flow of information to personnel and training activities.

(c) Clarification and substantiation of stated personnel and training requirements.

SECTION III

DERIVATION OF INFORMATION

This section establishes requirements for the derivation of personnel and training information. Each of the stated requirements defines a necessary process in the systematic determination of personnel and training requirements, and does not constitute a required product. Information generated in carrying out these processes will be recorded to the extent necessary to satisfy prescribed basic data requirements (Section II-3-c).

1. System Analysis

The first step in the determination of personnel and training requirements is the identification of human tasks involved in system operation and support. The identification of tasks will be based upon consideration of the system mission, environment, and materiel.

a. Mission Analysis

(1) The system mission(s) will be analyzed to identify the various operations necessary for their accomplishment, including reconnaissance, combat, planning, surveillance, deployment, etc. This identification must be as detailed as possible as it forms the basis for determination of all personnel and training requirements.

(2) All quantitative aspects of system operations must be specified as they determine both the nature and quality of human performance. These quantitative aspects will be derived from system performance requirements and will include range, speed, accuracy, rate of fire,

recycle or turn-around-time, mobility, reaction time, kill probability, availability requirements, etc.

(3) Where no mission analysis, operations analysis, etc., has been conducted as part of overall system design, the following information will be utilized in the identification of system operations:

(a) Operational, support, and organizational plans or concepts specific to the system in question.

(b) User requirements as stated in the Army Long Range Capabilities Plan, Combat Development Objectives Guide, and various combat development study reports.

(c) Official doctrine relating to operations, support, and organization, as described in Army regulations, command directives, field manuals, etc.

b. Environment

All environmental conditions capable of affecting human performance will be identified, including enemy activities, physical objects, terrain, weather, temperature, noise, illumination, etc. This identification will include indirect requirements created by the effect of an environment upon materiel, e.g., maintenance requirements.

c. Materiel

(1) All materiel items with which personnel must interact will be identified including:

(a) Prime equipment such as vehicles, control consoles, explosives, etc.

(b) Support equipment such as test equipment, tools, spare parts, handling equipment, etc.

(c) Life support equipment such as protective clothing, survival equipment, etc.

(2) The identification of materiel will include not only end items, but specific controls, displays, panels, circuitry, etc., to the extent permitted by materiel design.

(a) Early identification of materiel characteristics will be based upon general information available in research, state-of-the-arts, and technological feasibility reports.

(b) With the initiation of materiel design, information sources will include qualitative materiel requirements, total feasibility studies, technical characteristics, contractor proposals, engineering concepts, and detailed design characteristics.

(3) Continuous liaison will be maintained with materiel design personnel in order to assure the timely capture of critical design information not readily determinable from normal sources, e.g., design drawings, blueprints, circuit diagrams, etc. Information critical to determination of personnel and training requirements includes:

(a) Simplified design concepts, e.g., troubleshooting diagrams.

(b) Equipment performance characteristics, e.g., circuit outputs and tolerances.

(c) Special operating and maintenance procedures.

(d) Unusual safety requirements.

d. Task Identification

Mission operations, environments, and materiel will be analyzed simultaneously to identify all required tasks.

(1) All system operations will be analyzed to identify tasks requiring utilization of equipment by personnel including control, tracking, monitoring tasks, etc.

(a) Where the order of tasks is critical, the sequence will be identified (e.g., flow chart) in order to assure completeness and proper phasing.

(b) Where the absolute time relationship among tasks is critical, tasks must be examined against a real time base (e.g., "time-line" analysis) in order to prevent individual overloads.

(2) All equipment end items will be analyzed to identify tasks directed toward support of the equipment itself, e.g., supply, servicing, maintenance, etc.

(3) The identification of tasks will include not only routine tasks, but also those unscheduled tasks which result from the effects of such contingencies as enemy action, equipment failures, environmental influences, etc.

(4) Initial task identification will utilize the earliest available information concerning proposed system characteristics in order to permit early identification of personnel and training requirements.

e. Performance Standards

(1) The quantitative aspects of all tasks will be identified including the following:

(a) Speed--Maximum permissible time for task completion.

(b) Accuracy--Limits of acceptable task performance, e.g., control tolerances.

(c) Reliability--Maximum acceptable error probability, e.g., landing aborts.

(2) Performance standards must be set so as to assure achievement of system performance requirements (e.g., missile count down). Where fixed system performance requirements are not applicable, task performance standards will be established upon consideration of the following:

(a) Criticality of performance to system operation and safety.

(b) The ability to detect inadequate performance in time to prevent adverse effect.

(c) The relation of performance levels to the amount of back-up equipment (prime and support) required to meet system performance requirements.

(d) Task frequency as it affects:

1 Relation of performance levels to overall system effectiveness.

2 Ability to sustain high performance levels.

(e) The relation of individual performance levels to unit manning requirements.

(f) The relation of performance levels to personnel and training requirements.

(g) Potential hazard to equipment and personnel.

(3) For non-routine tasks, average standards may be prescribed, e.g., mean component repair time.

(4) The setting of realistic performance standards will in all cases require consideration of:

(a) The detailed steps required in task performance.

(b) The job context in which the task will be performed.

2. Analysis of Tasks

Each task will be analyzed into its component steps, including for each step the specific human inputs and required outputs. The object of this analysis is to provide an accurate basis for the determination of human characteristics underlying successful task performance. This analysis will be based upon an examination of the interaction of personnel with system equipment, other system personnel, and various aspects of the system environment.

a. Level of Analysis

(1) The level of detail to which human inputs and outputs may be specified will vary throughout system development, depending upon the availability of system design data.

(a) Prior to the initiation of materiel design, the analysis may be limited to identifying the general nature of the input information and the required output activities.

(b) With the establishment of an overall equipment configuration, the general nature of the materiel associated with the human inputs and outputs will be incorporated in the analysis, e.g., displays, controls, tools, etc.

(c) Upon establishment of detailed equipment design characteristics, the analysis must identify the specific qualitative and quantitative aspects of materiel associated with human inputs and outputs, e.g., "if meter B reads less than 10 volts, turn POWER-ON switch to READY position".

(2) The performance standards for each output will be specified as necessary to assure fulfillment of, or permit realistic setting of, overall task performance standards (paragraph 1-e-(2)).

b. Unscheduled Tasks

(1) The analysis of unscheduled tasks will require:

(a) Determination of the effect of each contingency upon the human inputs (symptom indications, target presentation, etc.).

(b) Determination of the appropriate output for each input (troubleshooting checks, control action, etc.).

(2) Where feasible, all required human inputs and outputs will be determined to permit preparation of appropriate procedures. Where such is not feasible, owing to the variety and/or uncertain nature of contingencies, a sufficient number of situations will be analyzed to permit identification of the types of decisions with which system personnel will be confronted.

(3) Where feasible, simulation will be used for:

(a) Exercising the system to detect likely contingencies.

(b) Determining effect of contingencies upon human input sources.

(c) Evaluating the effect of alternative outputs upon system performance.

Simulation may range from a simple paper "work through" to complex computer or dynamic equipment simulation.

(4) The analysis of contingencies will specifically include all equipment failures for the analysis of maintenance tasks. This analysis will be consolidated with similar failure prediction and/or analysis as required in:

(a) Maintainability and reliability programs, or

(b) Preparation of maintenance allocation charts.

(5) The analysis of troubleshooting tasks will embrace the sequence of failure indications and equipment checks required for progressive isolation of each failure. The identification of inputs will consider the precise effect of each failure upon normal operating displays, special readouts, and all potential test points. The determination of outputs will include operation of failed equipment, test equipment, tools, spare parts, etc., as required in troubleshooting checks.

(6) Where tasks may be performed in more than one manner (e.g., troubleshooting technique) the analysis will incorporate those operations which achieve the optimum balance between performance standards and underlying personnel and training requirements.

3. Determination of Duty Positions

The various tasks and task elements will be grouped into duty positions to permit assignment of individual responsibilities.

a. The determination of positions will be accomplished in such a manner as to achieve:

(1) Fullest possible utilization of available work time;

(2) Utilization of all performance capabilities in operational units as deployed in the field;

(3) Performance of all tasks by a single individual without excessive movement, travel time, etc.;

(4) Homogeneity of required capabilities so as to facilitate selection and training;

(5) Similarity to the configurations of capabilities in existing military and civilian specialties to exploit transfer;

(6) Clear separation of required capability levels in order to provide effective utilization of personnel representing differing responsibility, aptitude, training, and/or experience;

(7) A path of advancement among positions.

b. The same tasks may be assigned to positions of differing levels of responsibility, competence, etc., where:

(1) Utilization of available personnel is extended;

(2) Adequate work loads are assured at all positions;

(3) Work exceeding capabilities of lower level personnel may be referred without compromise of system performance.

c. Sufficient positions will be identified to assure completion of required tasks. Establishment of required manning levels will be based upon consideration of:

(1) Frequency and duration of scheduled tasks;

(2) Estimated frequency and duration of unscheduled (contingency) tasks;

(3) System performance requirements, e.g., equipment availability, turn-around time, etc.;

(4) Time during which system will be manned (e.g., work shifts);

(5) Anticipated loss of personnel time due to travel, enemy action, etc.

d. Following identification of duty positions, the analysis of tasks will be extended to identify interactions among personnel, including both <u>simultaneous</u> task sharing (e.g., missile launching) and <u>successive</u> task sharing (e.g., referral of repair to higher echelon).

4. <u>Analysis of Required Capabilities</u>

The capabilities required to meet task performance requirements must be identified. This will include determination of requirements for job knowledges, aptitudes, and physical characteristics.

a. Nature of Analysis

(1) Personnel and training requirements must be based upon the detailed performance requirements identified in the analysis of tasks in order to assure that:

(a) All those characteristics needed to assure effective human performance have been identified;

(b) Each personnel and training requirement is justified by a specific performance requirement.

(2) The analysis must encompass all characteristics required to:

(a) Perceive inputs

(b) Identify and interpret inputs

(c) Select appropriate outputs

(d) Effect outputs

(3) This analysis must identify the specific characteristics which underlie task performance, e.g., information, aptitudes, etc. This requirement will not be satisfied by mere description of tasks proceeded by "ability to," or "knowledge of," etc., or by simple classification, e.g., "repair skill".

(4) Early in system development, personnel and training requirements will be based upon analysis of the general nature of tasks. With the beginning of detailed equipment design, the specific human inputs and outputs must become the basis for this analysis. At all stages, the most detailed available performance information must be utilized in the identification of personnel and training requirements.

(5) Personnel and training requirements will be cross-referenced against the specific tasks and task steps from which they were derived in order to facilitate substantiation and updating of requirements.

b. Job Knowledges

(1) Determination of Information Requirements

The knowledges required to enable personnel to perform their assigned tasks must be itemized. Knowledges will consist of the specific information needed to identify and interpret inputs as well as to select and effect appropriate outputs. This information will include the following:

(a) Identifying information--Information concerned with system properties, required to permit identification and interpretation of inputs.

(b) Procedures--Information describing the inputs and their corresponding outputs (including precise input-output relations for motor tasks).

(c) Technical data--Information describing the equipment, environment, mission characteristics, enemy, etc., required to permit personnel to decide upon the appropriate outputs.

(d) Theoretical information--Information concerned with basic laws, required in the derivation of technical data.

(2) Complexity of Information

(a) Where feasible, job knowledges should consist of procedural or highly simplified technical information which can be:

1 Learned with minimum aptitude and training, and

2 Directly applied to job performance with a minimum of calculation, manipulation, etc.

(b) The determination of the appropriate degree of information complexity will be based upon consideration of:

1 The relation of information complexity to speed of performance and likelihood of error;

2 Available aptitude levels within the existing manpower pool;

3 The degree to which career potential can support and justify the extensive training and experience required for acquisition and utilization of complex information;

4 The likelihood of unexpected contingencies which could require use of more basic technical or theoretical information;

5 The rate of equipment modification and/or obsolescence as it affects the cost of generating and updating simplified information;

6 The extent to which the volume of highly detailed procedural information will create storage and retrieval problems.

(c) Where the same tasks or task elements are assigned to duty positions differing in degree of responsibility, competence, etc. (Section III-3-b), that level of information complexity most appropriate to each separate position will be identified.

(3) Training Objectives

Training objectives will include all performance standards (Section III-1-e) and specific knowledges which must be achieved through formal individual and unit training. Stated objectives must assure safe and effective utilization of materiel at all times as well as ultimate attainment of specified performance standards within the operational situation. Establishment of optimum objectives for training will be based upon consideration of the following:

(a) Efficiency with which complex knowledges (e.g., logic, theory, etc.) can be acquired under formal versus on-the-job training;

(b) Degree of realism (e.g., noise, stress, etc.) attainable in classroom training;

(c) Effect of sub-standard OJT performance upon system effectiveness, manning requirements, safety, etc.;

(d) Availability of instructor personnel, training equipment, spare operational equipment, etc., on the job;

(e) Relative economy of classroom versus on-the-job training (e.g., student-instructor ratio, training facilities, etc.).

Guidance on matters concerning training resources will be obtained from the appropriate training activity.

(4) Coordination of Technical Information

In recognition of the close relationship between job knowledges and the technical information provided in printed job supports, the following coordinative requirements are established:

(a) Content of job supports must correspond to job knowledges in assuring the availability of information needed for effective job performance;

(b) Job supports must compliment established knowledges in providing partial supports where appropriate (e.g., check lists, reference tables, etc.);

(c) Job knowledges that must include that information necessary for identification and utilization of job supports themselves;

(d) To avoid duplication, job supports and job knowledges must be derived from a single analysis of technical information required for effective human performance.

c. Perceptual-motor coordinations

(1) Those tasks involving rapid perceptual-motor coordinations and, therefore, requiring practice to meet specified performance standards, will be analyzed to determine the following:

(a) The nature of critical perceptual cues, including both external cues (e.g., displays, terrain, drift, etc.) and internal cues (e.g., muscular feedbacks, position cues);

(b) Quantitative relations between system cues and required motor outputs, e.g., rate of tracking;

(c) System feedbacks, e.g., control lags;

(d) Facilitating responses such as grip, stance, etc.

(2) Perceptual-motor requirements will be derived from anticipated system response characteristics as determined from basic system performance data, e.g., vehicle acceleration rates.

(3) Empirical techniques such as motion study will be employed where feasible using dynamic simulation, early prototypes, or operation of equipment.

d. Aptitudes

Those basic human characteristics required for effective performance must be specifically identified.

(1) Intellectual Requirements

The analysis will identify those intellectual capabilities required to:

(a) Learn and retain job knowledges;

(b) Apply job knowledges to decision making, problem solving, complex interpretation, and other situations involving logical reasoning.

The analysis may be restricted to unusual requirements and should identify such requirements in terms of available measures, preferably those included in the Army Classification Battery. No attempt should be made to specify qualification scores, cut-off points, or other requirements of an official personnel nature.

(2) Perceptual-Motor Abilities. The input-output relationships for all perceptual-motor tasks will be analyzed to identify measurable underlying motor abilities including rate of manipulation, finger dexterity, hand-eye coordination, etc.

(3) Personal Characteristics. Task performance will be analyzed to identify requirements for unusual behavior characteristics. This will include performances involving hazards to personnel, emotional stress, continued confinement, tedious activity, etc. Requirements should be specified in terms of characteristics which can be reasonably assessed through tests, personal history, interview, etc.

e. Physical Characteristics

(1) All task steps will be examined to identify physical characteristics required for:

(a) Sensing inputs, e.g., acuity, thresholds, fatigue, level, etc.;

(b) Effecting outputs, e.g., strength, reach, reaction time, etc.

(2) The environment (including all material) will be examined to identify physical characteristics related to general job suitability, e.g., height and weight restrictions, health, etc.

(3) Identification of physical requirements may be limited to the detection of exceptions from a specified set of "normal" characteristics.