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Selecting Presentation Modes According To Personnel Characteristics And The Nature of Job Tasks

Part I: Job Tasks

(1)

AD A038511

by

Thomas E. Powers, Ph.D.

University of Maryland Baltimore County

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This report deals with the generic behaviors involved in technical job task performance. It describes civilian and military efforts in developing behavioral descriptions of job task performances and in doing job task analyses, and it contains an annotated bibliography of works on such efforts. The report also describes a survey conducted of enlisted personnel assigned to a cross-section of technical ratings toward identifying the generic characteristics of Navy technical job tasks. The final → next page

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Cont.
20. section of the report provides hypothetical descriptions of the conditions of job task performance, the head/book distribution of knowledge/skill elements, and a taxonomy of generic job tasks performed in conjunction with the use of technical data.

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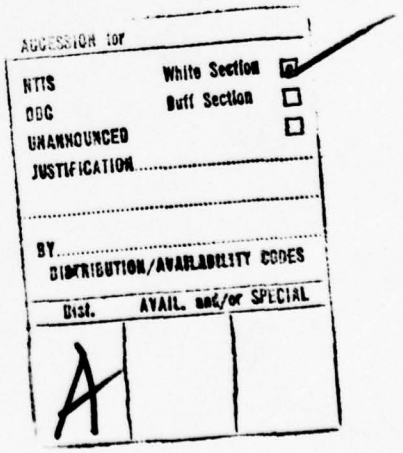


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I

INTRODUCTION

Background

Complaints from many Navy activities have indicated that a significant number of Navy technical manuals (TMs) are defective. One major defect in many TMs apparently has had to do with poor quality of presentation modes for transmitting information essential to performing operator and maintenance tasks. A common criticism is that many TMs are difficult to use. That is to say, writing levels are not matched to user abilities; there is an inadequate balance among "what to do", "how to do", and "why"; formats are not standardized; etc. Such defective TMs can have an adverse effect on Fleet operational readiness if these TMs are critical to the satisfactory performance of certain operation and maintenance tasks. The Navy Technical Information Presentation Program (NTIPP) was created and funded as a major effort to find solutions to these problems.

A major assumption behind any endeavor to improve the kinds of defects described above is that there is a causal relationship between TM quality and user performance. Put simply, it is assumed that the capability of maintenance technicians to perform troubleshooting tasks on a piece of hardware, for example, is dependent in part upon the capacity of the related technical manual to present troubleshooting procedures in a manner which is comprehensible to

the technician.

As such, this aspect of the TM question can be defined as a technical information presentation problem. Specifically, an apparent mismatch between the information vehicle (the TM) and the information user (the technician) results in unsatisfactory operation/maintenance performance -- i.e., either from misunderstanding or non-use of the TM.

This research employs instructional design concepts in dealing with the TM question. Any use of instructional design concepts in examining a mismatch between user characteristics and TM characteristics presupposes that a TM is, in a broad sense, an instructional or learning vehicle. The assertion that a better match between a TM and a user will result in better operator and maintenance practices could be rephrased to say: If "learner" (technician) characteristics can be better matched with the "learning vehicle" through which information is presented (the TM), "learning" (operator and maintenance performance) will be more effective.

The instructional design concept which is most compatible with both current Navy Training philosophy and contemporary practices in the vocational training community is Instructional Systems Development (ISD). In its most simple form, an ISD approach defines learning in terms of observable performances, and attempts to focus on the congruity among the three major components of any learning process: the learner, the required learning performance, and the

learning vehicle. To follow the learning process in terms of the three components: (1) Salient characteristics of the learner (ability, learning style, etc.) are matched with (2) the required learning as defined by precise descriptions of the cognitive/motor behaviors to be performed, and finally (3) the learning vehicle (be it an intricate instructional strategy or a more simplified media/format combination for presenting information) is selected which is most suited to "1" in accomplishing "2". This requires that there be congruity among the three components, and instructional design concepts are important tools in producing a valid mix of the three components.

In summation, the information presentation problems associated with many TMs seem to lend themselves to this kind of an approach. The TM (or more likely an appropriate portion thereof) can be thought of as a "learning" vehicle through which the technician (the "learner") performs operator or maintenance job tasks (the required "learning" performance). It is essential that an attempt is made to create a match among: (1) user ("learner") characteristics; (2) job tasks to be performed (required "learning"); and (3) media/format configurations (the "learning" vehicle). Viewed in that way, appropriate portions of a TM can be thought of as "learning" tools for eliciting cognitive/motor behaviors appropriate to the performance of related operator or maintenance job tasks.

Purpose

The overall purpose of this research is to investigate a relationship among Navy personnel characteristics, job tasks, and presentation modes. Any such successful investigation would provide a conceptual basis for selecting presentation modes appropriate to the nature of job tasks and variations in job task performers.

As previously described, there must be congruity among the three major components: personnel characteristics, job tasks, and modes of presentation (format configurations used to communicate technical information). The nature of the match among these three components is assumed to impact on the effectiveness of technical performance itself, and may even bear a relationship to job satisfaction and self-esteem among personnel.

The research of this project involves four principal endeavors as follows:

1. Generic Job Tasks: The identification of those categories of job tasks, which are common to all or most of the technical Navy ratings, and which usually require technical data presentation for their performance.

2. Personnel Characteristics: The identification of trends and variations in the aptitudes of Navy enlisted personnel according to their Navy occupation specialties (ratings).

3. Presentation Modes: The identification of a useful inventory of formats for presenting technical information.

4. Decision-making Model: The development, from 1, 2, and 3 above, of a tentative model for selecting presentation modes according to personnel aptitudes and job task categories.

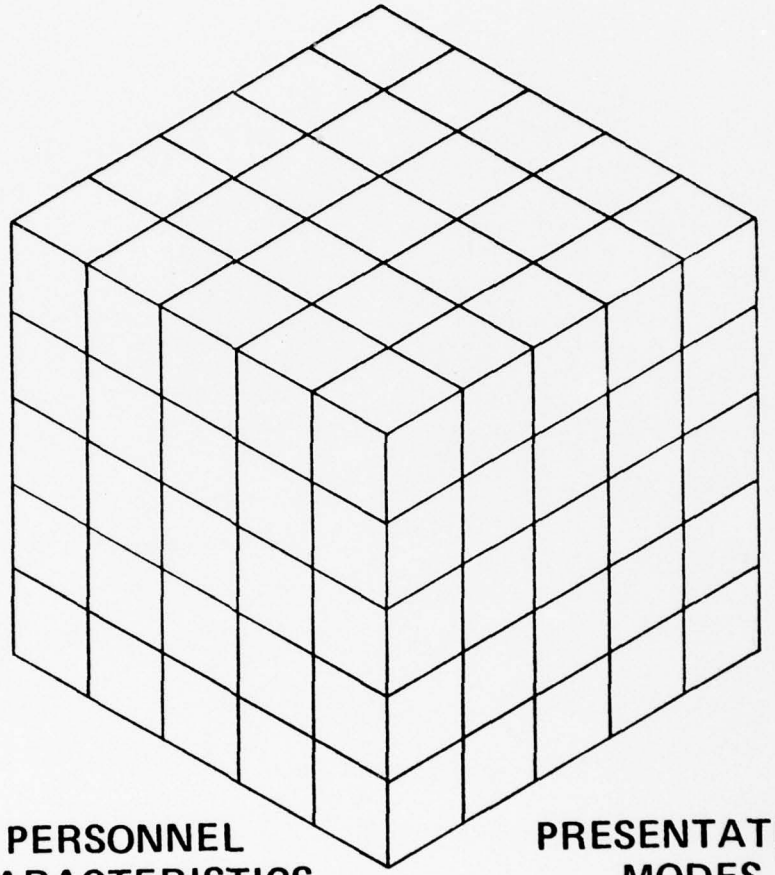
The research on generic job tasks, personnel characteristics, and presentation modes is intended to yield information concerning: descriptions of general job task categories requiring technical data; certain characteristics of personnel which usually are related to performance; and an inventory of presentation modes differentiated by various format combinations. An analysis of interrelationships among these three components is intended further to result in the development of a model for selecting presentation modes which are appropriate to differences in job tasks and personnel. Hypothetical statements about interrelationships among the three components from findings and theories encountered in completing research on each component represent the final product of this project. An example of such a hypothetical statement is: A Navy technician with "personnel characteristic" A should be able to perform "job tasks" 1, 2, and 3 when technical data are presented through "presentation modes" I and II. The aggregate of hypothetical statements could conceivably be seen as a three-dimensional structure (personnel characteristics, job tasks, presentation modes) in which each cube defined a level of match/mismatch for its alignment of parts from the three

components. Figure I is a graphic illustration of such a structure.

The purpose of this particular report is to describe the efforts involved in identifying categories of job tasks common to most Navy technical ratings. The report is divided in to three parts: (1) civilian and military efforts in developing behavioral definitions of job task performance; (2) survey work conducted at Navy training/fleet sites to identify common categories of job tasks; and (3) a tentative taxonomy of generic job tasks performed through the use of technical data.

FIGURE 1

THREE-DIMENSIONAL
MODEL



II

BEHAVIORAL DESCRIPTIONS OF JOB TASK PERFORMANCE: CIVILIAN AND MILITARY EFFORTS

Overview

The history of empirical and conceptual developments in education and training toward specifying behavioral criteria for job task performances dates largely from the period following World War II when more effective training programs were required to develop the necessary technical skills for increasingly more sophisticated equipment and hardware found in both the civilian and military communities. Traditional education and training programs which had emphasized general teaching behaviors for instructors were rapidly replaced by programs which emphasized specific learning outcomes in students. "What should a student be able to DO?" became key in defining instructional objectives, selecting instructional methods, and conducting instructional evaluation. In the world of work, both civilian and military, jobs were analyzed in an attempt to define the critical performances (or behaviors) which potential job performers had to master. Such job analyses produced job tasks inventories, around which training could be organized, and attempts were usually made to arrange the required performances for a job in some logical learning sequence, including the identification of essential knowledge and skill elements, so

that training, as well as job mobility, could proceed along a clearly defined path.

An outgrowth of defining specific behaviors in various technical occupations was the search by many investigators for ways of classifying job task performances according to similar elements. That is, behavioral classifications were sought which would be common to most, if not all, common to a great number of technical occupations. The implications of identifying any such generic classifications of performances seemed apparent: Such a scheme might be "timeless", not only cutting across different occupation groups, but surviving rapid and significant changes in equipment and hardware which would require training updates and changes. Therefore, the development of generic classifications of job performances was viewed by many as critical to any education and training programs which could be responsive to demands for spontaneity, practicality, and effectiveness in training outputs during an age when equipment/hardware innovations and modifications seem to be an every day happening.

Classifications of Learning Performance

One of the earliest researchers to attempt to classify learning performances was Benjamin S. Bloom whose division of education objectives into three domains (cognitive, affective, and psychomotor) was architechtural in the Navy eventually categorizing its content by knowledge, attitudes, and skills. Perhaps Bloom's most significant initial contribution was in urging education and training personnel to define instructional objectives in terms of measurable human perfor-

mances. The conceptual framework for Bloom's taxonomy of educational objectives in the cognitive domain (Bloom, 1956) was also the basis for later contributions in the affective domain (Krathwohl et al, 1964) and psychomotor domain (Harrow, 1972). The main categories are:

COGNITIVE DOMAIN TAXONOMY

(Bloom, 1956)

1.00 Knowledge

1.10 Knowledge of specifics
1.20 Knowledge of ways and means of dealing with specifics
1.30 Knowledge of the universals and abstractions in the field

Testing for Knowledge, and illustrative test items

1.10 Knowledge of specifics
1.20 Knowledge of ways and means of dealing with specifics
1.30 Knowledge of the universals and abstractions in a field

2.00 Comprehension

2.10 Translation
2.20 Interpretation
2.30 Extrapolation

Testing for Comprehension, and illustrative test items

2.10 Translation
2.20 Interpretation
2.30 Extrapolation

3.00 Application

The educational implications of objectives in the application category.

Testing for Application, and illustrative test items

4.00 Analysis

4.10 Analysis of elements
4.20 Analysis of relationships
4.30 Analysis of organizational principles

Testing for Analysis, and illustrative test items

4.10 Analysis of elements
4.20 Analysis of relationships
4.30 Analysis of organizational principles

5.00 Synthesis

Educational Significance of Synthesis objectives

5.10 Production of a unique communication
5.20 Production of a plan, or proposed set of operations
5.30 Derivation of a set of abstract relations

6.00 Evaluation

6.10 Judgments in terms of internal evidence
6.20 Judgments in terms of external criteria

Testing for Evaluation, and illustrative test items

6.10 Judgments in terms of internal evidence
6.20 Judgments in terms of external criteria

AFFECTIVE DOMAIN TAXONOMY

(Krathwohl et al, 1964)

1.0 Receiving (Attending)

1.1 Awareness
1.2 Willingness to Receive
1.3 Controlled or Selected Attention

2.0 Responding

2.1 Acquiescence in Responding
2.2 Willingness to Respond
2.3 Satisfaction in Response

3.0 Valuing

3.1 Acceptance of a Value
3.2 Preference for a Value
3.3 Commitment

4.0 Organization

4.1 Conceptualization of a Value
4.2 Organization of a Value System

5.0 Characterization by a Value or Value Complex

5.1 Generalized Set
5.2 Characterization

PSYCHOMOTOR DOMAIN TAXONOMY

(Harrow, 1972)

1.00 Reflex Movements

- 1.10 Segmental Reflexes
- 1.20 Intersegmental Reflexes
- 1.30 Suprasegmental Reflexes

2.00 Basic-Fundamental Movements

- 2.10 Locomotor Movements
- 2.20 Non-Locomotor Movements
- 2.30 Manipulative Movements

3.00 Perceptual Abilities

- 3.10 Kinesthetic Discrimination
- 3.20 Visual Discrimination
- 3.30 Auditory Discrimination
- 3.40 Tactile Discrimination
- 3.50 Coordinated Abilities

4.00 Physical Abilities

- 4.10 Endurance
- 4.20 Strength
- 4.30 Flexibility
- 4.40 Agility

5.00 Skilled Movements

- 5.10 Simple Adaptive Skill
- 5.20 Compound Adaptive Skill
- 5.30 Complex Adaptive Skill

6.00 Non-Discursive Communication

- 6.10 Expressive Movement
- 6.20 Interpretive Movement

Gagne (1965) further refined the idea of defining educational objectives according to specific, measurable human performances by suggesting the importance of clearly defining the CONDITIONS under which performance is expected. For example, the use of technical data to perform a job task would be seen as a condition for satisfactory job task performance. That is to say, the use of certain tech-

-nical data presented in some understandable form would be a necessary condition for job performance to take place. In deciding upon the conditions for performance, accurate assessment of a performer's capabilities at the time job task performance is required was seen as critical. In the example above, one condition for performance would be the ability of the performer to read and comprehend technical data, and, more exactly, his ability to respond to the most effective stimulus (e.g., a diagram rather than written text) in order to perform.

Consequently, Gagne would argue that defining the conditions under which performance is expected to take place is critical in assuring that performance WILL take place. Prior capabilities and learning have to be considered in defining conditions for performance. In the case of a technician, the information (and its arrangement) which is provided in order to perform a job task must be part of a repertoire of previously acquired knowledge. The essential point suggested here is aptly expressed by Gagne as follows:

> It is in fact the existence of prior capabilities that is slighted or even ignored by most of the traditional learning prototypes. And it is these prior capabilities that are of crucial importance in drawing distinctions among the varieties of conditions needed for learning. The child who is learning to tie his shoelaces does not begin this learning "from scratch"; he already knows how to hold the laces, how to loop one over the other, how to tighten a loop, and so on. The child who learns to call the mailman "Mr. Wells" also does not begin

> without some prior capabilities: he already knows how to imitate the words "mister" and "Wells", among other things. The theme is the same with more complex learning. The student who learns to multiply natural numbers has already acquired many capabilities, including adding and counting and recognizing numerals and drawing them with a pencil. The student who is learning how to write clear descriptive paragraphs already knows how to write sentences and to choose words.[1]

In developing the concept of conditions for performance, Gagne expouses a theory of learning contingency in which eight types of learning (performance) are distinguished according to eight sets of conditions under which changes in capabilities of the performer are brought about. In order of learning contingency, they are:[2]

> Type 1: Signal Learning. The individual learns to make a general, diffuse response to a signal. This is the classical conditioned response of Pavlov (1927).
>
> Type 2: Stimulus-Response Learning. The learner acquires a precise response to a discriminated stimulus. What is learned is a connection. (Thorndike, 1911) or a discriminated operant (Skinner, 1938), sometimes called an instrumental response. (Kimble, 1961).
>
> Type 3: Chaining. What is acquired is a chain of two or more stimulus-response connections. The conditions for such learning have been described by Skinner (1938) and others, notably Gilbert (1962).
>
> Type 4: Verbal Association. Verbal Association is the learning of chains that are verbal. Basically, the conditions resemble those for other (motor) chains. However, the presence of language in the human being makes this a special type because internal links may be selected from the individual's previously learned repertoire of language (cf. Underwood, 1964).
>
> Type 5: Multiple Discrimination. The individual learns to make n different identifying responses to as many different stimuli, which may resemble each other in physical appearance to a greater or lesser degree. Although the learning of each stimulus-response connection is a simple type 2 occurrence, the connections tend to interfere with each other's retention (cf. Postman, 1961).

Type 6: Concept Learning. The learner acquires a capability of making a common response to a class of stimuli that may differ from each other widely in physical appearance. He is able to make a response that identifies an entire class of objects or events (cf. Kendler, 1964).

Type 7: Principle Learning. In simplest terms, a principle is a chain of two or more concepts. It functions to control behavior in the manner suggested by a verbalized rule of the form "If A, then B", where A and B are concepts. However, it must be carefully distinguished from the mere verbal sequence "If A, then B", which, of course, may also be learned as type 4.

Type 8: Problem Solving. Problem solving is a kind of learning that requires the internal events usually called thinking. Two or more previously acquired principles are somehow combined to produce a new capability that can be shown to depend on a "high-order" principle.

In the above, one type of learning (performance) is distinguished from the next according to prerequisites which, in turn, serve to connect the levels in hierarchical order. Problem Solving (type 8) requires as prerequisites: Principles (type 7), which requires as prerequisites: Concepts (type 6), which requires as prerequisites: Multiple Discriminations (type 5), which requires as prerequisites: Verbal Associations (type 4) or Chaining (type 3), which requires as prerequisites: Stimulus-Response connections (type 2).[3]

A number of researchers have attempted to develop taxonomies of generic human performances. Each generic item usually is a category by which behaviors with the same mental and/or physical elements can be classified. For example, "disassembling" can be regarded as a generic classification of human behaviors used in a large number of diverse jobs. In the Navy, an engineman might disassemble an engine; an electrician's mate, an electrical circuit;

an ordnance man, a firing mechanism; etc. While each occupational specialty will no doubt have its own unique equipment to be disassembled, the main mental and/or physical elements involved in disassembling are probably similar for all. As a result, one ought to be able to treat many questions related to training, the development of job performance aids, methods for presenting technical data, etc. in a similar way for job tasks involving disassembling. Therefore, the importance of identifying generic classifications of the endless number of individual job tasks which define some 100 or more Navy occupations would seem essential to an effective and efficient process of providing necessary training and on-the-job information to job task performers.

A couple of examples of systems for classifying human performances developed by researchers concerned with job task behaviors of Navy personnel should prove useful. Willis and Peterson (1961) developed nineteen "task/behavior categories" as generic operational behaviors for using training devices. Their categories included:

(1) Non-Verbal Detection: Detection of some critical physical signal such as (a) a target on a radar scope, (b) an auditory signal of equipment malfunction, or (c) a visual cue for starting an operating procedure.

(2) Non-Verbal Identification: Identification of equipment configurations.

(3) Verbal Detection: Monitoring communications equipment.

(4) Verbal Identification: Identifying verbal stimuli or cues such as codes and diagrams or symbols such as those used in mathematical and natural languages.

(5) Recalling Facts: Recall of information such as equipment nomenclature of function, codes, configurations, locations, etc.

(6) Recalling Principles: Recall of information such as complex relationships between control inputs, output indications, and possible equipment malfunctions.

(7) Recalling Procedures: Recall of information such as procedures involved in assembly or disassembly of a complex piece of mechanism, replacement of defective components, or fueling or arming a weapon platform.

(8) Using Principles, Inferring: Application of complex relationships such as those involving control inputs, modes of operation, output indications, and possible equipment malfunctions; or use of principles in threat evaluation and weapon assignment.

(9) Making Decisions - Alternatives Given: Certain types of complex equipment malfunction diagnosis, complex system check-out, or threat evaluation and weapon assignment.

(10) Making Decisions - Alternatives Unspecified: Certain types of complex equipment malfunction diagnosis, complex system check-out, or threat evaluation and weapon assignment.

(11) Making Decisions - Alternatives Unknown: Certain types of complex equipment malfunction diagnosis, complex system check-out, or threat evaluation and weapon assignment.

(12) Positioning Movement: Handling of materials, operating controls.

(13) Repetitive Movement: Turning a screwdriver or wrench, hammering, using a hand file or saw, etc.

(14) Continuous Movement: Tracking tasks such as following a target with a gun or with fire-control equipment, or operating the steering mechanism of a moving vehicle.

(15) Serial Movement: Typing, radar set turn-on procedures, portions of system check-out routines.

(16) Static Reaction: Maintaining proper sight-target relationship in aiming a rifle, holding an electrode in place when welding, or maintaining optimal postural adjustment when monitoring a radar scope.

(17) Oral Verbalization: Person-to-person (s) vocal communication --either face-to-face or via electronic/mechanical transmission.

(18) Written Verbalization: Writing in special codes or symbols or in new natural or mathematical languages.

(19) Other (Overt) Verbalization: Use of conventionalized gestures or specialized sign languages such as the semaphore and the dactylological (deaf-mute) systems.

A similar systematic approach was taken by Aagard and Braby (1976) in their concern for training for common military job tasks. Drawing upon the work of Gagne (1965), Gagne and Briggs (1974), and the Interservice Procedures for Instructional Systems Development (1975), they list eleven types of elemental learning tasks for which learning guidelines and algorithms can be utilized in creating an instructional delivery system. The point to be made here for efficiency and effectiveness is that any one generic task can classify a large segment of job task behaviors, and presumably the learning guidelines and algorithm for that one generic task will apply to all. The generic learning tasks are:

LEARNING TASKS	BEHAVIORAL ATTRIBUTES
1. RECALLING BODIES OF KNOWLEDGE	1. Concerns verbal or symbolic learning. 2. Concerns acquisition and long-term maintenance of knowledge so that it can be recalled.
2. USING VERBAL INFORMATION	1. Concerns the practical application of information. 2. Generally follows the initial learning of information through the use of the guidelines. 3. Limited uncertainty of outcome. 4. Usually little thought of other alternatives.
3. RULE LEARNING AND USING	1. Choosing a course of action based on applying known rules. 2. Frequently involves "If... Then" situations.

3.	RULE LEARNING AND USING - Continued	3. The rules are not questioned, the decision focuses on whether the correct rule is being applied.
4.	MAKING DECISIONS	1. Choosing a course of action when alternatives are unspecified or unknown. 2. A successful course of action is not readily apparent. 3. The penalties for unsuccessful courses of action are not readily apparent. 4. The relative value of possible decisions must be considered - including possible trade offs. 5. Frequently involves forced decisions made in a short period of time with soft information.
5.	DETECTING	1. Vigilance - detect a few cues embedded in a large block of time. 2. Low threshold cues; signal to noise ratio may be very low. 3. Scan for a wide range of cues for a given "target" and for different types of "targets".
6.	CLASSIFYING	1. Pattern recognition approach of identification - <u>not problem solving</u>. 2. Classification by non-verbal characteristics. 3. Status determination - ready to start. 4. Object to be classified can be viewed from many perspectives or in many forms.
7.	IDENTIFYING SYMBOLS	1. Involves the recognition of symbols. 2. Symbols to be identified typically are of low meaningfulness to untrained persons. 3. Identification, not interpretation, is emphasized.

7.	IDENTIFYING SYMBOLS - Continued	4. Involves storing queues of symbolic information and related meanings.
8.	VOICE COMMUNICATING	1. Speaking and listening in specialized terse languages. 2. Often involves the use of a specific message model. Standard vocabulary and format. 3. Also concerns clarity of voice, enunciation, speed. 4. Timing of verbalization is usually critical - when to pass information. 5. Typically characterized by redundancy in terms of information content. 6. Involves extensive use of previously overlearned verbal skills, or overcoming overlearned interfering patterns. 7. Task may be difficult due to presence of background noise.
9.	RECALLING PROCEDURES, POSITIONING MOVEMENT	1. Concerns the chaining or sequencing of events. 2. Includes both the cognitive and motor aspects of equipment set-up and operating procedures. 3. Procedural check lists are frequently used as job aids.
10.	GUIDING AND STEERING, CONTINUOUS MOVEMENT	1. Tracking, dynamic control: a perceptual-motor skill involving continuous pursuit of a target or keeping dials at a certain reading such as maintaining constant turn rates, etc. 2. Compensatory movements based on feedback from displays. 3. Skill in tracking requires smooth muscle coordination patterns - lack of overcontrol.

10.	GUIDING AND STEERING, CONTINUOUS MOVEMENT - Continued	4. Involves estimating changes in positions, velocities, accelerations, etc. 5. Involves knowledge of display-control relationships.
11.	PERFORMING GROSS MOTOR SKILLS	1. Perceptual - motor behavior - emphasis on motor. Premium on manual dexterity, occasionally strength and endurance. 2. Repetitive mechanical skill. 3. Standardized behavior, little room for variation or innovation. 4. Automatic behavior - low level of attention is required in skilled operator. Kinesthetic cues dominate control of behavior.

Armed Services Task Analyses

The Armed Services have in part used the ideas of researchers like Bloom, Gagne, and others in the last two decades in conducting analyses of the job tasks performed by personnel. The major purpose for these job task analyses has been to identify the job task behaviors required of personnel and to devise training and on-the-job information (e.g., job performance aids, technical data, etc.) more appropriately in support of the job tasks to be performed.

(1) Air Force

The initial thrust in job task analyses efforts came from the Air Force Occupational Research Project, established in 1957. A major part of that project was the collection, analysis, and reporting of information defining work performed by personnel. Through job

inventories, the Air Force has been able to collect data from thousands of personnel representing a cross-section of Air Force occupations. With information collected for any one occupation (e.g., engine mechanic) being organized by a given advancement continuum (i.e., apprentice, journeyman, first-line supervisor, and superintendent), each occupational specialty can be described in terms of a subset of tasks collected in the inventory and arranged hierarchically according to prerequisite steps.

An inventory is constructed, not for a particular position or specialty, but for an entire career ladder. The inventory includes work done at the apprentice, journeyman, supervisor, and superintendent levels, since an incumbent may perform tasks which are above or below his designated skill level. An officer inventory similarly includes tasks of entry level, line, field, and staff officer grades. In some instances where it is suspected that incumbents may perform tasks outside their designated ladder, several career ladders have been combined so that a particular survey instrument may cover tasks over a broad career field.

During a survey, incumbents are asked to fill out a background information sheet, indicating such items as their grade, command, and time in military service. They are also required to answer a short questionnaire concerning such things as the courses they have taken, the types of equipment they have worked on, the tools they use, and the adequacy of technical manuals. In every survey, incumbents

indicate the tasks they perform as part of their current job and report how their work-time is distributed among those tasks. They also write in pertinent unlisted tasks which they perform so that these may be considered for inclusion in future revisions of the inventory. Incumbents may also be asked for information of some secondary factor, such as frequency of performance, amount of supervision required or exercised, or the need for additional training.

In recent years, the Comprehensive Occupational Data Analysis Programs (CODAP) has become the principal vehicle by which occupational data are collected, analyzed, and sorted out.[4]

(2) Army

The Army adopted the Air Force CODAP system in 1974. At the end of 1976 the Army had job task data on 376 of its Military Occupational Specialties (MOS). Similar to the Air Force, the Army can use its CODAP information to define specific job tasks for each MOS according to skill levels which coincide with differences in pay grade. Five skill levels have been designated: Level 1 (pay grades E1-E4); Level 2 (pay grade E5); Level 3 (pay grade E6); Level 4 (pay grade E7); and Level 5 (pay grades E8-E9). In the case of a MOS 63H (automotive specialty for example), skill levels 1 and 2 are for an automotive repairman; skill level 3, for an automotive repairman foreman; and skill levels 4 and 5, for automotive repairman supervisor. For any MOS, the job task requirements are defined in terms of specific mental/physical performances.[5]

(3) Marine Corps

The Marine Corps has been and continues to be a strong proponent of task analysis and automation of collected data.

The Marine Corps began its task analysis program as a fully operational effort. Experts from all the other services were invited to assist in the training of Marine Corps analysis. The program became operational because it was considered that sufficient research in task analysis had already been conducted by the other military services.

In 1969, the Marine Corps was instrumental in conversion of the Comprehensive Occupational Data Analysis Program (CODAP) from the IBM 7040 version to a 360/65 system, which significantly reduced computer run time while improving data presentation.

On-site observation/interview is used extensively in development of task inventories, and on-site administration of questionnaires by Marine Corps Task Analysis Teams is the favored method.

Computer printouts are analyzed by Marine Corps Task Analysis Teams and military managers are made aware of survey results.[6]

(4) Coast Guard

The U. S. Coast Guard occupational analysis program has progressed rapidly since development and administration of the Electronics Technician (ET) rating task inventory in 1969. Subsequently, the following ratings have been surveyed and results analyzed:[7]

Boatswain's Mate (BM)
Yeoman (YN)
Damage Controlman (DC)
Engineman (EN)
Aviation Machinist's Mate (AD)
Aviation Electronic's Technician (AT)
Aviation Electrician's Mate (AE)
Aviation Structural Mechanic (AM)
Aviation Survivalman (ASM)

An officer occupational analysis program and special career management studies are being conducted concurrently with the enlisted surveys.

Survey questionnaires are developed at U. S. Coast Guard Service schools, and after a technical review by senior personnel of the rating are mailed to billet incumbents who complete the questionnaires under the supervision and guidance of a survey proctor.

Survey returns are processed in accordance with the joint services CODAP system.

(5) Navy

(a) Navy Occupational Task Analysis Program (NOTAP)[8]

Navy activities in job task analyses date back to 1965 when the Chief of Naval Personnel requested that research be initiated in the design and development of a billet (job) evaluation system for Navy enlisted billets. However, the inability of the Navy to collect and process vast amounts of occupational information at that time hampered the development of a Navy-wide billet evaluation system until the establishment of the Navy Occupational Task Analysis Program (NOTAP) in 1971. Since then, like the Army, Navy NOTAP people have relied on the Air Force CODAP

computer programs in developing and clustering job description information.

Although NOTAP was initiated primarily to field test, Navy-wide, a method of accumulating occupational data from enlisted personnel in jobs in the aviation rating, plans presently include NOTAP surveying all of the enlisted ratings by the end of FY 77. In brief, NOTAP proceeds as follows in conducting job task analyses: (1) A task inventory is constructed by a cross-section of experts in a particular rating; (2) The task inventory is used to survey up to 30% of the personnel in that rating, including every NEC, pay grade, and duty type, to determine the incidence of performance of the tasks in the inventory; (3) A job task analysis is conducted of the survey data gathered to identify task clusters (job categories) by pay grades; (4) From the job task analysis, a job task inventory (or inventories, in the case of multi-specialty ratings -- e.g., radar, communications, etc. for ET's) is prepared; (5) Lastly, a training task analysis is made of the job task inventory in order to develop training task inventories, along with specific learning objectives and curricular designs to achieve necessary training.

It is important to note that the NOTAP process is aimed primarily at specifying what personnel in ratings DO. These performance statements have been intended for use in devising an improved personnel advancement system, as well as defining

requirements for task performance.[9] With respect to the latter point, training, job performance aids (JPA's), and technical data probably represent the major requirements for bringing personnel to perform specific job tasks identified through NOTAP. The main question to be answered, however, is what requirements (training, JPA, technical data) and what kinds and how much of them are necessary for personnel to perform particular job tasks.

(b) Personnel Qualification Standards (PQS)[10]

Similar to NOTAP, the Personnel Qualification Standards (PQS) program applies task analysis procedures to determine the knowledge and skill elements required to qualify personnel for Navy jobs. Unlike NOTAP, however, PQS is concerned about tasks related mainly to Navy equipments and systems rather than tasks by ratings. Furthermore, NOTAP task descriptions are based on what a sailor DOES in his job, while PQS on what a sailor OUGHT TO DO in his job. The central thrust of PQS is toward operation and maintenance tasks performed by personnel for specific watch stations connected with specific equipments and systems.

Both programs are valuable because they define Navy job tasks in terms of precise, observable performances. Furthermore, those mental and physical elements which are necessary prerequisites for job task performance are also specified in observable performance definitions. The arrangement of the mental and physical elements in the most appropriate (valid) learning order,

as well as the determination of the conditions under which learning (performance) is to be demonstrated (i.e., the technician using his head only, using a JPA, using technical data, etc.), is a major interest of NTIPP. More exactly, which kinds of job tasks, and related sub-skills and knowledge elements, require technical data for a technician to perform those job tasks?

See Appendix V-A for annotated citations of selected civilian and military works dealing with the analysis and definition of job task performances.

NOTES

[1]Robert M. Gagne', The Conditions of Learning. 2nd. Edition (Holt, Rinehart and Winston, Inc., 1970), pp. 22-23.

[2]Ibid., pp. 63-64.

[3]Gagne' has found insufficient evidence to conclude that Stimulus-Response Connections (Type 2) require Signal Learning (Type 1) as a prerequisite.

[4]Raymond E. Christal, The United States Air Force Occupational Research Project. AFHRL-TR-73-75. Brooks Air Force Base, Texas: Occupational Research Division, Air Force Human Resources Laboratory, January, 1974.

[5]Darrell A. Worstine and Helmut H. Hawkins, Information Guide to Selected CODAP Programs, Task Criticality Methodology and the Occupational Survey Process. U. S. Army Personnel Center, Alexandria, Virginia: Military Occupational Research Division, Personnel Management Development Directorate, November, 1975.

[6]For information on the Navy Occupational Task Analysis Program (NOTAP), see: C. T. Marshall, Occupational Analysis: Transition of the Navy Occupational Task Analysis Program NOTAP) From Research to Operational Status -- Evaluation of Program and Summation of Results. WTR 73-37. Washington Navy Yard, Washington, D.C.: Naval Personnel Research and Development Laboratory, June, 1973.

[7]Ibid.

[8]Ibid.

[9]NOTAP job task information was intended in part to support a revised enlisted personnel hierarchy consisting of apprentices (E1-3), ourneymen (E4-6), and supervisors (E7-9).

[10]For information on the Personnel Qualification Standards (PQS) Program see OPNAV Instruction 3500.34B of 3 March 1975.

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III

GENERIC JOB TASKS: DATA GATHERING ACTIVITIES

Objective

The central purpose of the research reported in this manuscript was to identify those general kinds of job tasks, performed in conjunction with technical manuals, which are common to most, if not all, Navy technical ratings. Three kinds of information were sought: (1) those job task categories which apply across technical ratings; (2) the mental and physical elements which make up each of those job task categories; and (3) the apparent conditions which define job task performance within each of the categories. The term "conditions" refers to the alignment between the prerequisite mental/physical skills possessed by the technician and the nature of the information presented in the technical manual.

Approach

1. Exploratory Development of Questionnaire

The initial step toward accomplishing the above objectives involved conducting two kinds of exploratory activities. One pertained to an intensive examination of the job task literature, (see Section II and Appendix V-A of this report), and in particular the use of Navy Occupation Task Analysis Program (NOTAP) materials on a large number of Navy technical ratings, to determine the existence of common job task categories and related mental and physical elements pertaining to job task performance. NOTAP publications were especially helpful in ultimately identifying common job task

categories for the final survey questionnaire (to be described later), while a NOTAP inventory entitled "Physical and Mental Characteristics Used in Meeting Job Requirements" was employed in the exploratory search for mental and physical elements.

The other exploratory effort had to do with data-gathering at the Service School Command, Great Lakes Naval Training Center. Two visits were conducted, the purpose of which was to obtain baseline information from petty officers in a number of technical ratings about job tasks they perform involving the use of technical data. The overall goal of these visits was to determine the kinds of questions, as well as the research design, which would be most appropriate to a subsequent survey of job tasks among a large number of Navy technical ratings.

In the two visits, some sixty-six petty officers, distributed among pay grades E4 to E9, completed questionnaires and took part in interviews. Nine technical ratings were involved in these exploratory activities as follows: Boiler Technician (BT); Machinist Mate (MM); Engineman (EN); Electrician's Mate (EM); Intercommunication Electrician (IC); Electronic Technician (ET); Gunner's Mate (GM); and Fire Control Technician (FT). A number of useful findings resulted from these visits, and are briefly reported below:

(1) The relative ease with which respondents were able to deal with questionnaires containing mental and skill concepts suggested that any final questionnaire containing similar items would probably pose no serious difficulty for the subjects to whom it would be

administered.

(2) Because a high number of responses, regardless of rating, tended to cluster on certain items dealing with the mental and physical characteristics of job task performance, it appeared that any follow-up search for common mental and skill elements for job tasks across ratings would probably yield positive results.

(3) Concepts having to do with the conditions of performance were generally comprehensible. For questions dealing with mental and physical elements in job task performance, respondents were able to distinguish between elements which a technician should find "in a book" (i.e., presented in a technical manual) and those which he should have "in his head" (i.e., mastered knowledge and skills) in performing job tasks.

(4) From the results of interviews and questionnaires, it appeared highly possible and feasible to construct an inventory of mental and physical elements of job task performance for subsequent use in investigating the existence of generic job tasks across technical ratings.

For detailed reports of the visits, see Appendices V-B and V-C.

2. Final Development of Questionnaire

A preliminary survey instrument of items containing job task categories and knowledge skill elements was constructed, relying chiefly on the results of the exploratory phase. This questionnaire was pre-tested with enlisted petty officers assigned to the Washington Navy Yard, Washington, D.C.. The pre-test revealed a few minor

problems in substance and format which were corrected in the final instrument. In its final form, the questionnaire contained three parts: (1) Respondent Characteristics; (2) Job Task Categories; and (3) Knowledge/Skill Elements in Performing Job Tasks. A copy is contained in Appendix V-D.

The "Respondent Characteristics" part merely requested general information about rate, maintenance/operator functions, etc. while the heart of the questionnaire dealt with "Job Task Categories" and "Knowledge/Skill Elements in Performing Job Tasks". Receiving verbal instructions, respondents were asked to identify with the ten general job task categories listed below:

Job Task Categories

Assemble/Disassemble

Test/Inspect

Troubleshoot/Repair

Clean/Lubricate

Flush/Purge

Adjust/Align

Remove/Replace

Rig/Unrig

Operate/Secure

Package/Unpackage

Beneath each of the above categories were two sets of items, one to indicate the frequency with which these job tasks are performed, and, the other, to indicate the knowledge/skill (K/S) elements

related to each category. For frequency, the terms "often", "occasionally", "seldom", and "never" were used; for indicating K/S elements, the numbers "1" . . . "32" were shown. The latter 32 numbers corresponded with 32 K/S elements as follows:

KNOWLEDGE/SKILL ELEMENTS IN PERFORMING JOB TASKS

1. Theory and/or principles of operation of equipment/hardware and/or its components.
2. How components and component parts relate to entire equipment/hardware system.
3. How components and component parts function.
4. Various formulas, rules, principles, etc.
5. Names of components and/or component parts in equipment/hardware.
6. Names of basic hand tools.
7. Names of special hand tools.
8. Names of basic testing equipment.
9. Names of special testing equipment.
10. How to use basic hand tools.
11. How to use special hand tools.
12. How to use basic testing equipment.
13. How to use special testing equipment.
14. How to read visual aids (e.g., diagrams, schematics, etc.)
15. How to read symbols.
16. How to read text materials.
17. Assembly/disassembly procedures.
18. Basic troubleshooting procedures.

19. Special troubleshooting procedures (e.g., isolating trouble through a fault logic chart.)

20. Basic test equipment procedures.

21. Special test equipment procedures.

22. Basic maintenance procedures.

23. Special maintenance procedures.

24. Basic safety rules.

25. Special safety precautions, warnings, trips, etc.

26. Visual Information: e.g., flows, patterns, interconnection of component parts and components, etc. (usually shown on a schematic, diagram, blueprint, sketch, etc.)

27. Specific calibrations, settings, clearances, voltages, etc. for tools, testing equipment, and/or component parts.

28. The meaning of symbols in schematics, drawings, diagrams, prints, etc.

29. Special terminology and vocabulary associated with your rating (technical jargon, acronyms, etc.)

30. Research and reference skills.

31. Ability to differentiate between component parts and components.

32. Skills in how to operate equipment/hardware.

Directions for completing the questionnaire were given verbally to respondents in three distinct but related steps. In step number one, petty officers were asked to indicate the frequency with which they performed job tasks related to each of the ten job task categories when performing maintenance and/or operator tasks on equipment/hardware in the Fleet. Specifically, for each category (Assemble/Disassemble, Test/Inspect, etc.), the respondent was to

indicate whether he was involved "often", "occasionally", "seldom" or "never" with respect to maintenance/operator jobs in his rating when working on equipment or hardware. When responding to each of the ten job task categories the subjects were told to concentrate on those equipment or hardware systems which most likely would absorb their time in the Fleet.

It should be noted at this point that seven of the job task categories were purposely selected as a result of the extensive examination of NOTAP task inventories of technical ratings. These seven tended to be common to all of the technical ratings for which NOTAP task inventories were available. This strongly supported the tentative validity of the seven categories as meaningful classifications of the kinds of jobs performed in most Navy technical ratings. The generic quality of each category seemed, of course, to depend upon the degree to which personnel in various ratings indicated involvement in the category. However, based on the frequency with which the seven categories appeared in NOTAP inventories, it seemed reasonable to require at least 80% of the respondents in each rating surveyed to identify with each of the categories in order to justify calling it a generic category. The seven categories were: Assemble/Disassemble, Test/Inspect, Troubleshoot/Repair, Clean/Lubricate, Adjust/Align, Remove/Replace, and Operate/Secure.

The other three categories (Flush/Purge, Rig/Unrig, and Package/Unpackage) were also taken from NOTAP task inventories, because they seemed to represent categories which were NOT common to most technical ratings. It was predicted, therefore, that respondents across

ratings would not identify with these three job task categories as high as the 80% frequency established for the other seven. The three categories were purposely included in the questionnaire as one check on the validity of responses. That is to say, if in general the respondents selected the three non-common categories as frequently as the other seven, it would diminish any case to be made about the generic quality of the latter categories and probably would reflect adversely on the validity of the responses to the entire questionnaire.

As for completing the questionnaire, in step one respondents circled the term which came closest to the frequency with which they performed job tasks described by each of the ten categories. Step two required them to study the list of thirty-two K/S elements in performing job tasks, and to indicate which of these elements tended to be involved when performing jobs related to each category. A respondent would circle any number under each job task category which corresponded with the number of a K/S element which was seen as involved in performing at least most of the maintenance and/or operator job tasks included in that category. For example, if most of a respondent's job tasks in the Assembly/Disassembly category required knowledge of "how components and component parts function", "names of basic hand tools", etc., he would circle the numbers "3", "6", etc. under "Assemble/Disassemble". Depending on his view, he could circle all or none of the thirty-two numbers under each job task category in which he indicated involvement (either "often", "occasionally", or "seldom") in completing step one of the questionnaire.

The third and final step required respondents to differentiate between circled K/S elements in each job task category according to elements which for them were "in the head" or "in the book". To be more precise, each respondent was to identify the elements that he probably knew from memory (e.g., "8", names of basic testing equipment) and those elements which required some form of information presentation (e.g., "27" special calibrations, settings, etc.) at the time job tasks were being performed. This was done by the respondent putting an "x" through any circled element which he had mastered completely or committed to memory.

The three steps in completing the questionnaire represented a narrowing procedure intended to converge in the last step on some of the conditions associated with performing actual maintenance and operator job tasks. Step one was intended to identify the broad categories of generic job tasks; step two, the K/S elements seemingly common to technical ratings for each category; and step three, the mastered K/S elements (those "in the head") and the K/S elements requiring some sort of information presentation (those "in the book"). Any final list of job task descriptions based on information from all three steps was seen as being potentially useful in identifying a tentative taxonomy of generic job tasks.

3. Selection of Respondents and Sites

Thirty* ratings representing a cross-section of Navy technical ratings involved in work on equipment and hardware were selected for

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*FTs and FTBs were treated as distinct ratings

purposes of administering the questionnaire. A list of rating descriptions is contained in Appendix V-E. Although the questionnaire was administered to over 500 petty officers, from E4 to E9, approximately fifty questionnaires were invalidated because of evidence of errors in completing them. Ultimately the responses of 452 petty officers were tabulated and analyzed. The breakdown of these respondents by ratings and pay grades is shown in Table 1.

Nine Navy Fleet/Training sites provided the personnel for this research. These were:

- Service School Command, Great Lakes Naval Training Center, November 3-5, 1976: BT, MM, EN, EM, IC, GM, FT, and ET ratings
- Naval Air Technical Training Command, Memphis, November 18-19, 1976: AE, AW, AX, AQ, AT, AO, AS, AD, and AM ratings
- Fleet Training Center, Norfolk, November 22, 1976: RM, HT, TM, and QM ratings
- Fleet ASW Training Center Atlantic, Norfolk, November 22, 1976: ST rating
- Fleet Combat Direction Systems Training Center Atlantic, Dam Neck November 23, 1976: EW and OS ratings
- Fleet Guided Missile School, Dam Neck November 23, 1976: MT and FTB ratings
- Service School Command, Naval Training Center, San Diego November 29-30, 1976: MR, HT, RM, DP, ET, QM, and SM ratings
- Fleet ASW Training Center Pacific, San Diego December 1-2, 1976: ST and TD ratings
- Fleet Combat Direction Systems Training Center Pacific, San Diego, December 3, 1976: OS rating

Results

1. Job Task Categories

Responses to questions about frequency of involvement in work which could be classified under the ten job task categories are

summarized in Tables 2 and 3. It should be noted, however, that personnel in the AD, AO, AM, and AS ratings had no opportunity to respond to the "Troubleshooting/Repair" category because, inadvertently, it was left off their questionnaire. Nevertheless several respondents from the four ratings added "Troubleshooting/Repair" as a category at the end of the questionnaire; however, the figures were not tabulated because there was no way of determining whether these additions represented the total response from each of the four ratings to the "Troubleshooting/Repair" question.

Interestingly, except for the "Troubleshooting/Repair" insertions from some respondents in the AD, AO, AM, and AS ratings, no other job task category dealing specifically with maintenance/operator job tasks on hardware and equipment was offered as an addition to the ten categories. Occasionally, personnel added "Administration," Supervision," and "Training" as categories, but, since none of these classified work behaviors bearing directly on hardware and equipment and because of their small number, they are not reported in this manuscript. The fact that some respondents offered "Troubleshoot/Repair" on questionnaires in which it was missing and that no other category was offered which pertained specifically to hardware and equipment suggests that the ten categories in the questionnaire were sufficiently inclusive to cover the range of job tasks for Navy technicians in performing maintenance and operator duties.

Table 2 shows that all seven categories predicted in advance as having the greatest chance of being common to the technical ratings

surveyed met the 80% criterion for tentative identification as a generic category. In fact, at least 90% of the respondents for each of the seven categories indicated they performed job tasks subsumed by the category. Particularly high involvement was reported for "Operate/Secure", "Test/Inspect", "Adjust/Align", and "Troubleshoot/Repair", with 98%, 98%, 95%, and 95% of the respondents respectively selecting these categories.

By contrast, the other three categories which were included as a check of the validity of the survey were well below the 80% criterion. Furthermore, about half of those who reported involvement in these three categories indicated that they were involved only "seldom" in the kind of work classified by the categories.

From Table 3, one can see that virtually without exception all personnel in almost every rating reported performing job tasks related to each of the seven appropriate job task categories. Only operation-oriented ratings like QM, SM, OS, RM, DP, AX, and AW showed less than 100% participation in some of these categories.

It is particularly interesting to note the significantly high number of respondents who reported performing job tasks related to operating/securing equipment and hardware. As illustrated in Tables 2 and 3, some 442 of 452 petty officers indicated involvement in the "Operate/Secure" category, with two-thirds reporting they performed such job tasks "often".

These findings suggest that it is unrealistic to discretely classify Navy enlisted technicians as either maintenance personnel

or operator personnel. Doubtless, most of a technician's duties will fall into either the maintenance area or operator area, but today's sailor seems to have to function, at least in part, in both areas. Table 4, which shows the distribution of responses to a question in the "Respondent Characteristics" section of the questionnaire (which asked if a respondent was mainly a maintenance technician or an operator) provides additional information on this last point. The figures (384, maintenance technician; 290, operator) show that many petty officers consider themselves both a maintenance technician and an operator.

2. Knowledge/Skill Elements

Although the original questionnaire contained only thirty K/S elements, a large number of respondents in the GM, FT, ET, MM, EN, BT, EM, and IC ratings -- the first ratings to complete the questionnaire -- suggested the addition of items 31 and 32. Therefore, every rating other than the above eight responded to the additional two items in a revised questionnaire. The fact that no other item was suggested by those surveyed is evidence that the list of thirty-two items seems to encompass the main K/S elements related to maintenance/operator job tasks.

Tables 5 to 11 incorporate a two-dimensional matrix (ratings and elements) to summarize responses for each of the generic job task categories: Operate/Secure, Test/Inspect, Adjust/Align, Troubleshoot/Repair, Clean/Lubricate, Remove/Replace, and Assemble/Disassemble. A mark (either "x" or "o") opposite a rating and beneath a K/S element

indicates that at least half of the respondents in the rating (who reported involvement in that category) felt the K/S element was important to most of the job tasks they performed in that category. An "x" signifies that at least a majority of the petty officers replying in the rating felt the K/S element was "in their head" -- that is to say, they believed they had satisfactorily mastered the K/S element; thus, making information presentation for that element unnecessary at the time job tasks involving the element are performed. An "o" signifies that at least a majority of the petty officers replying in the rating felt the K/S element was needed "in the book" -- that is to say, they believed they require information presentation for that element at the time job tasks involving the element are performed.

Although a detailed analysis of Tables 5-11 might prove worthwhile in identifying specific ratings/elements information for each category, the main findings are summarized in Table 12 and reported as follows:

(1) Rating Patterns: Similar K/S elements were selected by the vast majority of ratings for the job task categories: Operate/Secure, Test/Inspect, Adjust/Align, and Troubleshoot/Repair. The similarity in the first category was related to the high clustering by ratings on certain K/S elements; while in the latter three, the high clustering on most K/S elements. In the main, it was operation-oriented ratings like QM, SM, DP, and AW which showed the greatest deviation from the K/S patterns of the above latter three categories.

Although similar K/S patterns for the last three job task categories (Clean/Lubricate, Remove/Replace and Assemble/Disassemble) were less apparent by ratings than in the first four job task categories, there was some similarity in certain ratings on many elements (e.g., Ordnance and Engineering/Hull ratings for Assemble/Disassemble) and on a few specific elements (e.g., Aviation ratings for Clean/Lubricate and Remove/Replace) in one or more of the latter three categories.

(2) Element Patterns: Many K/S elements clustered fairly consistently across job task categories. Twenty-two K/S elements (1, 2, 3, 5, 6, 7, 10, 11, 14, 15, 16, 17, 22, 23, 24, 25, 26, 27, 28, 29, 31, and 32) were selected by at least half of the ratings in most job task categories; while fifteeen of these (1, 2, 3, 5, 6, 7, 10, 11, 14, 15, 16, 22, 24, 25, and 29) were selected by at least three-quarters of the ratings in most job task categories.

(3) Head/Book Patterns: As part of the analysis, evidence was examined concerning ratings which might be "in the head"-oriented or heavily "in the book"-oriented with respect to K/S elements. Those ratings with 75% of their K/S elements marked by "x" (in the head) or 75%, marked by "o" (in the book), were identified in each job task category. The 75% figure was an arbitrary criterion for possible "in the head" or "in the book" tendencies. Only TM's were consistently above the 75% criterion with respect to "in the head" marks across job task categories. However, with only three TM's having participated in the survey, no conclusion, however tentative, is drawn from that finding.

As for the "in the book" tendency, EN's, AO's, and AM's met the 75% criterion in at least a majority of the job task categories. Again, nothing conclusive is drawn from this finding, but it does raise a question about varying needs for technical information presentation according to differences in ratings (or more directly, according to general differences in personnel aptitudes within ratings).

The more appropriate head/book question for this research was related to any tendency across ratings for certain K/S elements to be either "in the head" or needed "in the book." Again, a 75% criterion was used. Those K/S elements in which 75% of the ratings showed "x" (in the head) or "o" (in the book) marks were identified for each job task category. Those K/S elements which met the "in the head" criterion in a majority of job task categories were 5, 6, 10, 14, 16, and 24; while those which met the "in the book" criterion in a majority of job task categories were 7, 11, 13, 17, 23, 25, 26, 27, and 30. By converting the numbers to K/S elements, the first finding suggests that most petty officers, regardless of technical rating, believe they have mastered (for the main kinds of maintenance/operator job tasks) those knowledge/skill requirements having to do with names of components and component parts; names and uses of basic hand tools; how to read visual aids and text materials; and basic safety rules. The second finding suggests that there is a particular requirement for technical information presentation in job task performances which involve the use of names and functions of special hand tools and special

test equipment; assembly/disassembly procedures; special maintenance procedures; special safety precautions; visual illustrations of flows, patterns, and interconnections of components and component parts; specific calibrations, settings, clearances, voltages, etc.; and research and reference skills.

TABLE 1

SURVEY PERSONNEL
RATINGS AND PAY GRADES

Ratings	Pay Grades E9	E8	E7	E6	E5	E4	Total
QM	1	1	5	1			8
SM			2	1			3
OS	1	2	7	4	6	2	22
EW			1	3	1		5
ST		1	4	6	5	1	17
TM			1	2			3
GM	2	4	6	7	5		24
FT		4	5	6	6	2	23
FTB			1	2	2	4	9
MT			3	4	1	3	11
ET		5	4	8	5		22
RM	1	1	7	9	2	6	26
DP	1	2	3	4	2	2	14
MM		6	4	5	2		17
EN			5	3	2		10
MR	1	1	6	6			14
BT	3	1	3	5	1		13
EM	2	5	9	6	7	3	32
IC		2	4	7	5	2	20
HT		2	10	4	3	4	23
AD			1	7	1		9
AT			1	8	8		17
AX		1	2	10	3	2	18
AW	1	2	1	6	2		12
AO			2	10	4		16
AQ				3	9		12
AE			3	9	7		19
AM		1	3	6	1		11
AS			2	1	4		7
TD			5	8	2		15
TOTAL	13	41	110	161	96	31	452

TABLE 2

FREQUENCY OF JOB TASK PERFORMANCE
(# and % of total respondents)

Job Task Category		Often	Occasion.	Seldom	Total Yes	Total No	Grand Total
Operate/Secure	#	298	96	48	442	10	452
	%	66	21	11	98	2	100
Test/Inspect	#	298	113	31	442	10	452
	%	66	25	7	98	2	100
Adjust/Align	#	196	172	60	428	24	452
	%	43	38	13	95	5	100
Troubleshoot/Repair	#	241	106	43	390	19	409
	%	59	26	11	95	5	100
Clean/Lubricate	#	169	141	107	417	35	452
	%	37	31	24	92	8	100
Remove/Replace	#	191	140	84	415	37	452
	%	42	31	19	92	8	100
Assemble/Disassemble	#	149	168	90	407	45	452
	%	33	37	20	90	10	100
Package/Unpackage	#	40	106	168	314	138	452
	%	9	23	37	69	31	100
Rig/Unrig	#	47	88	132	267	185	452
	%	10	20	29	59	41	100
Flush/Purge	#	30	87	119	236	216	452
	%	7	19	26	52	48	100

TABLE 3

INVOLVEMENT IN JOB TASK CATEGORIES
(counts by ratings)

No. of Respondents	Operate/ Secure		Test/ Inspect		Adjust/ Align		Troubleshoot/ Repair	
	Yes	No	Yes	No	Yes	No	Yes	No
8 QM's	8	0	8	0	8	0	5	3
3 SM's	3	0	3	0	0	3	2	1
22 OS's	22	0	22	0	20	2	13	9
5 EW's	5	0	5	0	5	0	5	0
17 ST's	17	0	17	0	17	0	17	0
3 TM's	3	0	3	0	3	0	3	0
24 GM's	24	0	24	0	24	0	24	0
23 FT's	23	0	23	0	23	0	23	0
9 FTB's	9	0	9	0	9	0	9	0
11 MT's	11	0	11	0	11	0	11	0
22 ET's	19	3	22	0	22	0	22	0
26 RM's	26	0	25	1	24	2	26	0
14 DP's	13	1	11	3	9	5	11	3
17 MM's	17	0	17	0	17	0	17	0
10 EN's	10	0	10	0	10	0	10	0
14 MR's	14	0	14	0	14	0	14	0
13 BT's	13	0	13	0	13	0	13	0
32 EM's	31	1	32	0	31	1	31	1
20 IC's	20	0	20	0	20	0	20	0
23 HT's	23	0	23	0	19	4	23	0
9 AD's	8	1	8	1	8	1	N/A	N/A
17 AT's	16	1	16	1	17	0	17	0
18 AX's	17	1	18	0	16	2	17	1
12 AW's	12	0	10	2	11	1	12	0
16 AO's	15	1	15	1	16	0	N/A	N/A
12 AQ's	12	0	12	0	12	0	11	0
19 AE's	19	0	18	1	17	2	19	1
11 AM's	11	0	11	0	11	0	N/A	N/A
7 AS's	6	1	7	0	6	1	N/A	N/A
15 TD's	15	0	15	0	15	0	15	0
Total	442	10	442	10	428	24	390	19

N/A: AD, AO, AM, and AS questionnaires failed to contain Troubleshoot/Repair Category.

Yes: Do perform job tasks in this category.

No: Do NOT perform job tasks in this category.

TABLE 3 (cont'd)

INVOLVEMENT IN JOB TASK CATEGORIES
(counts by ratings)

No. of Respondents	Clean/ Lubricate		Remove/ Replace		Assemble/ Disassemble	
	Yes	No	Yes	No	Yes	No
8 QM's	8	0	6	2	3	5
3 SM's	3	0	2	1	2	1
22 OS's	22	0	13	9	14	8
5 EW's	5	0	5	0	5	0
17 ST's	17	0	17	0	17	0
3 TM's	3	0	3	0	3	0
24 GM's	21	3	24	0	24	0
23 FT's	20	3	23	0	23	0
9 FTB's	9	0	9	0	9	0
11 MT's	11	0	11	0	11	0
22 ET's	18	4	21	1	21	1
26 RM's	24	2	21	5	23	3
14 DP's	13	1	8	6	5	9
17 MM's	16	1	17	0	17	0
10 EN's	10	0	10	0	10	0
14 MR's	14	0	13	1	14	0
13 BT's	12	1	12	1	13	0
32 EM's	31	1	31	1	31	1
20 IC's	20	0	20	0	20	0
23 HT's	21	2	22	1	23	0
9 AD's	8	1	8	1	8	1
17 AT's	17	0	17	0	15	2
18 AX's	15	3	15	3	15	3
12 AW's	8	4	11	1	7	5
16 AO's	12	4	14	2	14	2
12 AQ's	11	1	12	0	12	0
19 AE's	17	2	18	1	16	3
11 AM's	11	0	11	0	11	0
7 AS's	5	2	6	1	6	1
15 TD's	15	0	15	0	15	0
Total	417	35	415	37	407	45

TABLE 4

NUMBER INDICATING INVOLVEMENT
AS MAINTENANCE TECHNICIAN AND/OR OPERATOR

	Maintenance Technician	Operator
8 QM's	0	8
3 SM's	1	3
22 OS's	4	22
5 EW's	4	4
17 ST's	16	7
3 TM's	3	1
24 GM's	24	16
23 FT's	23	18
9 FTB's	9	9
11 MT's	11	11
22 ET's	21	5
26 RM's	17	26
14 DP's	2	12
17 MM's	16	12
10 EN's	10	6
14 MR's	9	10
13 BT's	13	11
32 EM's	32	15
20 IC's	20	11
23 HT's	22	21
9 AD's	9	5
17 AT's	17	5
18 AX's	18	9
12 AW's	5	12
16 AO's	15	9
12 AQ's	12	3
19 AE's	18	7
11 AM's	11	7
7 AS's	7	1
15 TD's	15	4
TOTAL	384	290

TABLE 5

JOB TASK CATEGORY: OPERATE/SECURE

Rating	Knowledge/Skill Elements															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
QM (8)	x			x	o									o		o
SM (3)	x		x		x											
OS (22)	x	x	o	o	x									o	o	x
EW (5)	x				x											x
ST (17)	o	o	o		o									o	o	o
TM (3)	x	x	x	o	x	x	x	x	x	x	x	x	x	x	x	x
GM (24)	x	o	x		o											
FT (23)	x	o			x											o
FTB (9)	x	x	x	o	x									x	x	x
MT (11)		x	o		x											x
ET (19)	o															o
RM (26)	x	x	x		o											o
DP (13)	x	x	x	o	x									x	x	x
MM (17)	x	x	x	o	x			o		o		o		o	x	x
EN (10)	x	o	x		o											o
MR (14)	x	x	x	x	x	x	x	x	o	x	o	o	o	x	x	x
BT (13)	x	x	x		o									x	x	x
EM (31)	x	x	x		x									x		x
IC (20)	x	o	x		x											x
HT (23)	x	x	o	o	x	o	o			o				o	o	x
AD (8)	o	o	o	o								o	o	o	o	o
AT (16)	o				o											x
AX (17)	o															x
AW (12)	x	x	x	x	x				x				o			x
AO (15)	x	o	o	o	o				o					o		o
AQ (12)	x	x	o		x	o										x
AE (19)	o	o	o		o											x
AM (11)	x	x	o	o	o	o	o			x	o			o	o	o
AS (6)	o	o	o		o									x		o
TD (15)	x			o												x

( ): Parenthetical number after each rating is the number of respondents who indicated performing job tasks in the above job task category.

o and x: Either symbol indicates that at least half the number of respondents in the parentheses felt the knowledge/skill element was important to performing most job tasks in the above category. BUT: "o" appears when at least half the number in the parentheses indicated needing information presented on that element when performing job tasks; "x", when at least half indicated NOT needing information presented on that element.

TABLE 5 (cont'd)

JOB TASK CATEGORY: OPERATE/SECURE

Rating	Knowledge/Skill Elements															
	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
QM (8)								x					o			o
SM (3)						x		x								x
OS (22)								x	o		o		x		o	x
EW (5)		x														x
ST (17)								x	o				x			o
TM (3)	o	x	o	x	x			x	o	o	o	x	x	o	x	x
GM (24)								x	o				x			
FT (23)								x	o				x			
FTB (9)				o		o		x	x				o			o
MT (11)								x	o				x			o
ET (19)								x	o							
RM (26)								x	o						o	x
DP (13)		o				x		x	o	o		x	x	x	x	x
MM (17)		x	o	o		o	o	x	x	o	o	o	o	o		
EN (10)		o	o	o		o	o	o	o	o	o	o	o			
MR (14)	o	x	o	o	o	x	o	x	x	o	o	o	o	o	o	x
BT (13)		o						o	o	o	o		o			
EM (31)								x	o		o		x			
IC (20)								x	o				o			
HT (23)		o				o		x	o	o	o	o	o	o	x	x
AD (8)		o		o	o	o	o	x	o		o		x			o
AT (16)								x	o				x			o
AX (17)								x	o				o			o
AW (12)		x	o		o			x	x	x	o		x	x	x	x
AO (15)						o	o	x	o					o		x
AQ (12)						x	o	x	o				x			x
AE (19)						o		x	o	o			o			o
AM (11)		o	o			o	o	x	o	o	o	o	o	o	o	o
AS (6)						o		x	o							o
TD (15)								x					x			o

TABLE 6

JOB TASK CATEGORY: TEST/INSPECT

Rating	Knowledge/Skill Elements															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
QM (8)	x	o	o	o	o											o
SM (3)	o	x			o											
OS (22)	o	o	o	o	o	x	o	x	o	x	o	x	o	x	x	o
EW (5)	x	o	o		x	x	o	o	o		o	x	o	x	x	x
ST (17)	x	o	o	o	x	x	o	x	o	x	o	x	o	x	x	x
TM (3)	x	x	x	o	x	x	x	x	x	x	x	x	x	x	x	x
GM (24)	x	x	x	o	x	o	o	x	x	x	o	x	o	x	x	x
FT (23)	x	x	x	o	x			x	x	x	o	x	o	x	x	x
FTB (9)	x	x	x	o	x	o		x	o			x	o	x	x	x
MT (11)	x	x	x	o	x			x	o			x	o	x	o	x
ET (22)	o	o	x	o	x			x	o			x	o	x	o	x
RM (25)	x	x	x		x			x	o			o	o	x	o	x
DP (11)	x	x	x		x	o				o				x		
MM (17)	x	x	x	o	x		o	o	o	x	o	x	o	o	o	x
EN (10)	o	o	o	o	o	x	o	x	o	x	o	o	o	o	x	x
MR (14)	x	x	x	o	x	x	x	x	o	x	o	x	o	x	x	x
BT (13)	x	x	x	o	o		o	x	o	x	o	x	o	o		x
EM (32)	x	o	o		o			x	o			x	o	x	x	x
IC (20)	x	o	x	o	x		o	x	o	x	o	x	o	x	x	x
HT (23)	x	x	x	o	x	x	o	x	o	x	o	x	o	x	x	x
AD (8)	o	x	o	o	x	o		o	o	x		x	o	x	o	x
AT (16)	o	x	o	o	x	x	o	x	o	x	o	x	o	x	x	x
AX (18)	x	o	o	o	x			x	o		o	x	o	x	o	x
AW (10)	x	o	o	o	o				o				o			x
AO (15)	o	o	x		o			o	o			o	o	o		o
AQ (12)	x	x	o		x	x		x	o	x	o	x	o	x	x	x
AE (18)	o	o	o		o	x	o	x	o	x	o	x	o	x	x	x
AM (11)	x	x	x	o	o	x	o	x	o	x	o	x	o	o	o	x
AS (7)	o	o	o	o	o	x	o	x		x	x	x	x	x	o	o
TD (15)	o	o	x	o	x	x	o	x	x	x	o	x	o	x	x	o

( ): Parenthetical number after each rating is the number of respondents who indicated performing job tasks in the above job task category.

o and x: Either symbol indicates that at least half the number of respondents in the parentheses felt the knowledge/skill element was important to performing most job tasks in the above category. BUT: "o" appears when at least half the number in the parentheses indicated needing information presented on that element when performing job tasks; "x", when at least half indicated NOT needing information presented on that element.

TABLE 6 (cont'd)

JOB TASK CATEGORY: TEST/INSPECT

Rating	Knowledge/Skill Elements															
	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
QM (8)								x			o		o			x
SM (3)						o	x									x
OS (22)		o		x				x	o		o	o	x	o	o	x
EW (5)		x	x	o	o	o	o	x	o	o	o		x		x	x
ST (17)	o	o	o	x	o	o	o	x	o	o	o	o	x	o	o	o
TM (3)	o	x	o	x	x	x	x	x	o	o	o	x	x	x	x	x
GM (24)	o	o		o	o			x	o	o	o	o	o	x		
FT (23)				x	o	x	o	x	o	o	o	x	x	o		
FTB (9)		o	o	o	o	o	o	x	o	o	o	o	x	o	o	o
MT (11)				x	o	o		x	o	o	o	o	x		o	x
ET (22)				x	o	o	o	x	o	o	o	o	x	o		
RM (25)		o		x	o			x	o	o	o	o	o		x	x
DP (11)						x		x	o				x		o	o
MM (17)	o	o	o	x	o			x	o	o	o	o	o	o		
EN (10)	o	o	o	o	o		o	o	o	o	o	o	o	o		
MR (14)	o	x	o	x	o	x	o	x	x	o	o	o	x	o	o	x
BT (13)	o	o	o	o	o	o	o	x	o	o	o		o	o		
EM (32)				x	o			x	o	o	x	o	o			
IC (20)	o	x	o	x	o	x	o	x	o	o	o	x	x	o		
HT (23)	o	o	o	x	o	o	o	x	o	o	o	o	o	o	x	x
AD (8)		o	o	o	o	x	o	x	o	o	o	o	x	x	o	x
AT (16)	o	o		x	o	x	o	x	o	o	o	x	x	o	o	o
AX (18)				x	o	o	o	x	x	o	o	x	x	o	x	x
AW (10)		o		o	o			x	o		o		x			x
AO (15)	o	o		o	o	o	o	x	o	o	o		o		o	o
AQ (12)		o	o	x	o	x		x	x	o	o		x	o	x	x
AE (18)				x	o	x	o	x	o	o	o	o	o		o	o
AM (11)		x	o	x	o	x	o	x	o	o	o	o	o	o	x	x
AS (7)		o	o	o	o	o	o	x	o	o	o	o	o	o	o	o
TD (15)	o	o	o	x	o	x	o	x	o	o	o	o	x	o	x	o

TABLE 7

JOB TASK CATEGORY: ADJUST/ALIGN

Rating	Knowledge/Skill Elements															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
QM (8)	x	x	x	o			o				o					o
SM (0)																
OS (20)	o	o	o	o	x	x	o	x	o	x	o	x	o	x	o	x
EW (5)	x	o	x		o	x	o	x	o	x	x	o	o	x	x	x
ST (17)	x	o	x	o	x	x	o	x	o	x	o	x	x	x	x	o
TM (3)	x	x	x	o	x	x	x	x	x	x	x	x	x	x	x	x
GM (24)	x	x	x	o	x	x	x	x	x	x	x	x	o	x	x	x
FT (23)	x	x	o	o	x	x	x	x	x	x	o	x	o	x	x	x
FTB (9)	x	x	x	o	x	x	o	x	x	x	o	x	o	x	x	x
MT (11)	o	x	x	o	x	x	o	o	o	x	o	x	o	x	o	x
ET (22)	o	o	x	o	x	x	o	x	x	x	o	x	o	x	x	x
RM (24)	x	x	x	o	x	x	o	x	o	x	o	x	o	x	o	x
DP (9)	x	x	x	o	x	x				x						
MM (17)	x	x	x	x	x	x	o	o	o	x	o	x	o	o	o	x
EN (10)	o	o	o	o	x	x	o	x	o	x	o	o	o	o	o	o
MR (14)	x	x	x	o	x	x	x	x	o	x	o	x	o	x	x	x
BT (13)	x	x	x	o	x	x	o	x	o	x	x	x	o	x	x	x
EM (31)	x	x	x		x	x	o	x	o	x	o	x	o	x	x	x
IC (20)	o	x	o	o	x	x	o	x	o	x	o	x	o	x	x	x
HT (19)	x	x	o	o	x	x	o	o		x	o	o	o	x	x	x
AD (8)	o	x	o	o	o	x	o	o	o	o	o	o		o		x
AT (17)	o	o	o	o	x	x	o	o	o	x	x	x	o	x	x	x
AX (16)	o	o	o	o	x	x	o	x	x	x	o	o	o	x	x	x
AW (11)	x	x	x		x		o	x	o	x	o	x	o	x	x	o
AO (16)	o	o	o		o	o	o	o	o	o	o	o	o			o
AQ (12)	x	x	x		x	x	o	x	x	x	o	x	o	x	x	x
AE (17)	o	o	o	o	o	x	o	x	o	x	o	x	o	x	x	x
AM (11)	o	o	x	o	o	x	o			x	o			o	o	o
AS (6)	o	o	x	o	o	x	x	x	o	x	x	x	x	x	o	x
TD (15)	o	o	x	o	x	x	o	x	x	x	x	x	o	x	x	x

( ): Parenthetical number after each rating is the number of respondents who indicated performing job tasks in the above job task category.

o and x: Either symbol indicates that at least half the number of respondents in the parentheses felt the knowledge/skill element was important to performing most job tasks in the above category. BUT: "o" appears when at least half the number in the parentheses indicated needing information presented on that element when performing job tasks; "x", when at least half indicated NOT needing information presented on that element.

TABLE 7 (cont'd)

JOB TASK CATEGORY: ADJUST/ALIGN

Rating	Knowledge/Skill Elements															
	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
QM (8)						x							o			x
SM (0)																
OS (20)				o				x	o	o	o	o	o	o	o	x
EW (5)	o	x	o	x	o	x	o	x	o	x	o	x	x	o	x	x
ST (17)	o	o		x	o	x	o	x	o	o	o	x	x	o	x	o
TM (3)	x	x	x	x	x	x	x	x	x	o	o	x	x	x	x	x
GM (24)	o			x	o	x	o	x	o	o	o	o	x	o		
FT (23)				x	o	x	o	x	o	o	o	x	x	o		
FTB (9)	o		o	o	o	o		x	x	o	o	x	x	o	o	o
MT (11)				o	o	o	o	x	o	o	o	o	o		o	o
ET (22)				x	o	o	o	x	o	o	o	x	x			
RM (24)	o	o		x	o	o	o	x	o	o	o		x		x	x
DP (9)	o	o				o		x					o		x	x
MM (17)	o	o	o	o	o	x	o	x	o	o	o	o	o	o		
EN (10)		o		o	o	o	o	o	o	o	o	o	o	o		
MR (14)	o	x	o	x	o	x	o	x	x	x	o	x	x	o	o	x
BT (13)	o	o	o	o	o	o	o	x	o	o	o		o	o		
EM (31)	o			x		x		x	o	o	o	x	o	x		
IC (20)	o			x	o	x	o	x	o	o	o	x	o	x		
HT (19)	o	o	o	o	o	x	o	x	o	o	o	o	o	o	x	x
AD (8)		x		o	o	x	o	x	o	o	o		x	x	o	o
AT (17)	o	o	o	x	o	x	o	x	o	o	o	x	x	o	o	o
AX (16)				x	o	x	o	x	o	o	o	o	x	o	o	o
AW (11)		x	o	x	o		o	x	o	o	o		x	o	o	x
AO (16)		o		o	o	o	o	x	o	o	o		o		o	o
AQ (12)	o			o	o	x	o	x	o	o	o	o	x	o	o	x
AE (17)				x	o	x	o	x	o	o	o	x	x			o
AM (11)	o	o	o	o	o	x	o	x	o	o	o	o	o	o	o	o
AS (6)	o	x		x	o	o	o	x	o	o	o	o	o	o	o	o
TD (15)	o	x	o	x	o	x	o	x	o	o	o	o	x	o	x	o

TABLE 8

JOB TASK CATEGORY: TROUBLESHOOT/REPAIR

Rating	Knowledge/Skill Elements															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
QM (5)	x			x	o	x	o									o
SM (2)	x	x			x	x				x		x				
OS (13)	o	o	o	o	o	x	o	x	o	x	o	o	o	x	x	x
EW (5)	x	o	x	o	x	x	o	x	o	x	o	x	o	x	x	x
ST (17)	x	o	x	o	x	x	o	x	o	x	o	x	o	x	x	x
TM (3)	x	x	x	o	x	x	x	o	x	x	x	x	x	x	x	x
GM (24)	x	x	x	o	x	x	x	x	o	x	x	x	o	x	x	x
FT (23)	x	x	x	o	x	x	x	x	x	x	x	x	o	x	x	x
FTB (9)	x	x	x	o	x	x	x	x	o	x	x	x	o	x	x	x
MT (11)	x	x	x	o	x	x	o	x	o	x	o	x	o	x	x	x
ET (22)	o	o	x	o	o	x	o	x	o	x	o	x	o	x	x	x
RM (26)	x	x	x	o	x	x	o	x	o	x	o	x	o	x	o	x
DP (11)	x	x	x	o	x											x
MM (17)	x	x	x	o	x	x	o	x	o	x	o	x	o	x	o	x
EN (10)	o	o	o	o	o	x	o	o	o	x	o	o	o	o	o	x
MR (14)	x	x	x	o	x	x	x	x	o	x	x	x	o	x	x	x
BT (13)	x	x	x	o	x	x	x	x	o	x	x	x	x	x	x	x
EM (31)	x	x	x	o	x	x	o	x	o	x	o	x	o	x	x	x
IC (20)	x	o	o	x	x	x	o	x	o	x	o	x	o	x	o	x
HT (23)	x	o	o	o	x	x	o	x	o	x	o	x	o	x	x	x
AD (0)	Not Applicable: Failed to Question Rating About This Category															
AT (17)	x	x	o	o	x	x	o	x	o	x	o	x	o	x	x	x
AX (17)	o	o	x	o	x	o	o	x	o	o	o	x	o	x	x	x
AW (12)	x	x	x	o	x			o	o			o	o			x
AO (0)	Not Applicable: Failed to Question Rating About This Category															
AQ (11)	x	x	x	o	x	x	o	x	x	x	o	x	o	x	x	x
AE (19)	o	o	o		o	x	x	x	o	x	x	x	o	x	x	x
AM (0)	Not Applicable: Failed to Question Rating About This Category															
AS (0)	Not Applicable: Failed to Question Rating About This Category															
TD (15)	o	o	x	o	x	x	o	x	x	x	o	x	o	x	x	x

( ): Parenthetical number after each rating is the number of respondents who indicated performing job tasks in the above job task category.

o and x: Either symbol indicates that at least half the number of respondents in the parentheses felt the knowledge/skill element was important to performing most job tasks in the above category. BUT: "o" appears when at least half the number in the parentheses indicated needing information presented on that element when performing job tasks; "x", when at least half indicated NOT needing information presented on that element.

TABLE 8 (cont'd)

JOB TASK CATEGORY: TROUBLESHOOT/REPAIR

Rating	Knowledge/Skill Elements															
	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
QM (5)		x											o			
SM (2)	o					o		x								x
OS (13)	o	o	o	o	o	o		x	o	o	o	o	x	o	o	x
EW (5)	o	x	o	x	o	x	o	x	o	x	o	x	x	o	x	x
ST (17)	o	x	o	x	o	x	o	x	o	o	o	x	x	o	x	x
TM (3)	x	x	o	x	x	x	x	x	o	o	o	x	x	x	x	x
GM (24)	o	x	o	x	o	x	o	x	o	o	o	x	x	o		
FT (23)	o	x	o	x	o	x	o	x	o	o	o	x	x	o		
FTB (9)	o	x	o	x	o	o	o	x	x	o	o	x	x	o	o	x
MT (11)	o	x	o	x	o	o	o	x	o	o	o	x	x	o	x	o
ET (12)	o	x	o	x	o	x	o	x	o	o	o	x	x	o		
RM (26)	o	x	o	x	o	o		x	o	o	o	x	x	o	x	x
DP (11)		x				x		x					x			x
MM (17)	o	x	o	x	o	x	o	x	o	o	o	o	o	o		
EN (10	o	o	o	o	o	o	o	o	o	o	o	o	o	x		
MR (14)	o	x	o	o	o	x	o	x	o	o	o	o	x	o	o	x
BT (13)	o	x	o	x	o	x	o	x	o	o	o	o	x	o		
EM (31)	o	x	o	x	o	x	o	x	o	o	o	x	x	o		
IC (20)	o	x	o	x	o	x	o	x	o	o	o	o	x	x		
HT (23)	o	x	o	x	o	x	o	x	o	o	o	o	o	o	x	x
AD (0)	Not Applicable: Failed to Question Rating About This Category															
AT (17)	o	x	o	x	o	o	o	x	o	o	o	x	o	o	o	o
AX (17)	o	x	o	o	o	x	o	x	o	o	o	o	x	o	x	x
AW (12)		x	o	o	o	o		x	x	o	o		x			x
AO (0)	Not Applicable: Failed to Question Rating About This Category															
AQ (11)	x	x	o	x	o	x	o	x	x	o	o	x	x	o	x	x
AE (19)	o	x	o	x	o	x	o	x	o	o	o	x	x	x	o	o
AM (0)	Not Applicable: Failed to Question Rating About This Category															
AS (0)	Not Applicable: Failed to Question Rating About This Category															
RD (15)	o	x	o	x	o	x	o	x	o	o	o	x	x	o	x	o

TABLE 9

JOB TASK CATEGORY: CLEAN/LUBRICATE

Rating	Knowledge/Skill Elements															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
QM (8)					o											o
SM (3)	o		x		x					x						
OS (22)					x	x				x				o		x
EW (5)			o		x	x				x						x
ST (17)		o	x		x	x	o			x	o			o		x
TM (3)			o		x	x	o			x	x			x	x	x
GM (21)	x	o	x		x	x	o			x	o			x	x	x
FT (20)				o	x	x				x	o			o		x
FTB (9)	x	x	x		x	x	o			x	o				x	x
MT (11)					o	o				x						x
ET (18)			o			x				x	o					x
RM (24)			o		o	x				x						o
DP (13)			x		o											
MM (16)	x	x	x		x	x	o			x	o			o		x
EN (10)					o	o				o					o	x
MR (14)	x	x	x		o	x	x	o		x	o	o	o	x	o	x
BT (12)		x			o	x				x	o					x
EM (31)					o	o				x						x
IC (20)			o		o	o	o			x	o			o		x
HT (21)	x	x	o		x	x	o			x	o			o	o	x
AD (8)			o		o	x				x						
AT (17)										x						o
AX (15)						x				x	o					
AW (8)	x	o	x							o	o					x
AO (12)			o		o					o						o
AQ (11)					x	x				x						x
AE (17)					o	x				x						x
AM (11)			o		o	x	o			x	o					o
AS (5)			o		o	x				x				x		o
TD (15)		o	x		x	x	o			x	o					o

( ): Parenthetical number after each rating is the number of respondents who indicated performing job tasks in the above job task category.

o and x: Either symbol indicates that at least half the number of respondents in the parentheses felt the knowledge/skill element was important to performing most job tasks in the above category. BUT: "o" appears when at least half the number in the parentheses indicated needing information presented on that element when performing job tasks; "x", when at least half indicated NOT needing information presented on that element.

TABLE 9 (cont'd)

JOB TASK CATEGORY: CLEAN/LUBRICATE

Rating	Knowledge/Skill Elements															
	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
QM (8)	o					o			o							o
SM (3)	o							x								x
OS (22)						x		x	o						x	x
EW (5)	o					x	o	o	o				o		x	
ST (17)	o					x	o	x	o	o		o	x		x	o
TM (3)	x					x	x	x	o			x	x		x	
GM (21)	o					x	o	x	o	o		o	x			
FT (20)	o					x	o	x	o				x			
FTB (9)	o					x	o	x	x				x	o	x	o
MT (11)						o		x								
ET (18)	o					x	o	x	o							
RM (24)	o					x		x	o						o	
DP (13)						x		x					x			x
MM (16)	o					x	o	x	o				o			
EN (10)						o		o	o	o						
MR (14)	o	o	o	o		x	o	x	o	o	o	o	o	o	o	x
BT (12)						o		x	o					o		
EM (31)	o					x	o	x	o							
IC (20)	o					x	o	x	o							
HT (21)	o					x	o	x	o	o	o	o	o	o	x	x
AD (8)	o					o		x	o				o			o
AT (17)	x					o	o	o	o							
AX (15)	o					x	o	x	o							
AW (8)						x		x	x				o		x	x
AO (12)	o					o		x	o						o	o
AQ (11)	o					o	o	x	o							
AE (17)	o					x		x	o							
AM (11)						x		x	o				x		o	o
AS (5)								x	o				o		o	
TD (15)	o					o	o	x	o				o	o	x	

TABLE 10

JOB TASK CATEGORY: REMOVE/REPLACE

Rating	Knowledge/Skill Elements															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
QM (6)	o				x	x	o				o					o
SM (2)	x	x	x		x	x				x						
OS (13)					o	x				x				x		x
EW (5)		o	o		x	x	o	x		x	o	x	o	x	x	x
ST (17)	o	o	o	o	x	x	o	o	o	x	o	o	o	x	x	x
TM (3)		x	x		x	x	x			x	x					x
GM (24)	x	x	x		x	x	x	x	o	x	x	x	o	x	x	x
FT (23)					o	x	o			x	o			x	o	o
FTB (9)	x	o	x	o	x	x	x	o	o	x	o	x	o	o	x	x
MT (11)	o	x	x		x	x	o			x	o			x		x
ET (21)					x	x	x			x	o			x	o	x
RM (21)	o	x	o		o	x	o			x	o			x		x
DP (8)	x	x	x		x	x				x						
MM (17)	x	x	x		x	x	o	x	o	x	o	x	o	x	o	x
EN (10)	o	o	o		o	x	o			x	o			o		o
MR (13)	x	o	o	o	x	x	o	o	o	x	o	o	o	x	x	x
BT (12)		x	o		x	x	x	x	o	x	x	x	o	x	x	x
EM (31)		o	o		x	x	o			x	o			o	x	x
IC (20)		x	o		x	x	o			x	o			x	x	x
HT (22)	x	x	o		x	x	o	x		x	o	x	o	x	x	x
AD (8)		o	o		o	x	o			x	o	o	o			x
AT (17)					x	x				x	o					x
AX (15)					o	x	o			x	o			o		o
AW (11)		x	o		x	x				x						x
AO (14)		o	o		o	x	o			x	o					o
AQ (12)				o	x	x	x			x	x					x
AE (18)					o	x	o			x	o					o
AM (11)		o	o		o	x	o			x	x	o		o	o	o
AS (6)	o	o	o		o	x	x			x	o			x	o	o
TD (15)	o	o	o		x	x	o	x		x	o	x		x	x	o

( ): Parenthetical number after each rating is the number of respondents who indicated performing job tasks in the above job task category.

o and x: Either symbol indicates that at least half the number of respondents in the parentheses felt the knowledge/skill element was important to performing most job tasks in the above category. BUT: "o" appears when at least half the number in the parentheses indicated needing information presented on that element when performing job tasks; "x", when at least half indicated NOT needing information presented on that element.

TABLE 10 (cont'd)

JOB TASK CATEGORY: REMOVE/REPLACE

Rating	Knowledge/Skill Elements															
	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
QM (6)	o							x							x	
SM (2)	o					o		x								
OS (13)	o							x	o	o			x		o	
EW (5)	o							x	o	o	o	x	x	o	x	x
ST (17)	o	o		o		x	o	x	o	o	o	o	o	o	x	o
TM (3)	x			x	o	x	x	x	o	o	o	x	x		x	x
GM (24)	o			x	o	x	o	x	o	o	o	x	x	o		
FT (23)	o					o	o	x	o	o	o	o	x	o		
FTB (9)	o					o	o	x	x	o	o	x			o	
MT (11)	o					x		x	o			o	x		x	
ET (21)	o					o	o	x	o	o	o		o			
RM (21)	o					o		x	o							o
DP (8)	o					x		x					o		o	
MM (17)	o					x	x	o	o	o	o	o	o			
EN (10)	o					x	o	o	o	o	o					
MR (13)	o	o	o	o	o	x	o	x	x	o	x	o	o	o	o	x
BT (12)	o					o	o	x	o	o	o	o	o	o		
EM (31)	o							x	o	o		x				
IC (20)	o					x		x	o	o	o			o		
HT (22)	o	o	o	x	o	x	o	x	o	o	o	o	o	o	x	x
AD (8)	o					x	o	x	o		o		o	x	o	o
AT (17)	o					x		x	o	o			o		o	
AX (15)	o					o		x	o							
AW (11)	o					x		x	x				o		x	x
AO (14)	o					o	o	x	o		o		o		o	o
AQ (12)	x					x	o	x	x		o				x	x
AE (18)	o					x	o	x	o							
AM (11)	o	o				x	o	x	o	o		o	o	o	x	o
AS (6)	o					o	o	x	o	o	o	o	o	o	o	x
TD (15)	o			o		x	o	x	o	o	o	o	o	o	x	o

TABLE 11

JOB TASK CATEGORY: ASSEMBLE/DISASSEMBLE

Rating	Knowledge/Skill Elements															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
QM (3)	o				o					x						o
SM (2)	x		x		x											
OS (14)	o	o	o		o	x	o	x		x	o	o		x	x	x
EW (5)		o			x	x	o	o	o	x	o	x	o	x	x	x
ST (17)	o	o	o	o	x	x	o		o	x	o		o	x	x	x
TM (3)	x	x	x		x	x	o	o	o	x	x	o		x	x	x
GM (24)	x	x	x		x	x	x	x	o	x	x	x	o	x	x	x
FT (23)	x	o	x		x	x	x			x	o			x	x	x
FTB (9)	o	x	x		x	x	o	x	o	x	x	x	o	x	x	x
MT (11)	x	x	o		x	x	x			x	o	o		x	o	x
ET (21)		o			x	x	x			x	o			x	o	x
RM (23)	x	x	x		x	x				x				x		x
DP (5)	x	x	x		x	x				x						x
MM (17)	x	x	x		o	x	o		o	x	o	x	o	x	x	x
EN (10)	o	o	x		o	x	o		o	x	o	x	o	x	x	x
MR (14)	o	x	o	o	x	x	x	o	o	x	x	o	o	x	x	x
BT (13)	x	x	x		x	x	o	x	o	x	x	o	o	x	x	x
EM (31)	x	o	x		x	x	o	o		x	o	o		x	o	x
IC (20)	x	x	x		x	x	o			x	o			x	x	x
HT (23)	x	o	x	o	x	x	o	x	o	x	o	x	o	x	x	x
AD (8)	o	o	o		o	x	o	o	o	x	o	x	o	x	o	x
AT (15)		o			x	x	o			x	o			x	x	x
AX (15)		o			o	x	o			x	o			x		o
AW (7)	o		o							o						x
AO (14)	o	o	o		x	x	o	o		x	o	o		o	o	o
AQ (12)	o	o	x		x	x	o			x	x			x		x
AE (16)		o	o		x	x	o			x	o			x	x	x
AM (11)	o	x	x		o	x	o			x	o			o	o	x
AS (6)	x	x	x		o	x	x			x	o			x	o	o
TD (15)	o	o	x		x	x	x	x		x	x	x		x	o	x

( ): Parenthetical number after each rating is the number of respondents who indicated performing job tasks in the above job task category.

o and x: Either symbol indicates that at least half the number of respondents in the parentheses felt the knowledge/skill element was important to performing most job tasks in the above category. BUT: "o" appears when at least half the number in the parentheses indicated needing information presented on that element when performing job tasks; "x", when at least half indicated NOT needing information presented on that element.

TABLE 11 (cont'd)

JOB TASK CATEGORY: ASSEMBLE/DISASSEMBLE

Rating	Knowledge/Skill Elements															
	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
QM (3)	o					o					o					
SM (2)		x				o										
OS (14)	o			o		o	o	x	o	o	o	x	x		o	o
EW (5)	o						o	x	o	x	o	x	x		x	x
ST (17)	o						o	x	o	o	o	x	x		x	o
TM (3)	x					o	o	x	o	o	o	x	x		x	x
GM (24)	x	o		x	o	x	o	x	o	o	o	o	x	o		
FT (23)	o					o	o	x	o	o	o	o	x			
FTB (9)	o	o	o	o	o	o	o	x	x	o	o	x	x	o	x	
MT (11)	o					o		o	o	o	o	x	o		x	o
ET (21)	o					o	x	o	o	o	o	o	o			
RM (23)	o					o		x	o	o			o		x	x
DP (5)	o	x				x		x	o				o		x	x
MM (17)	o	o			o	x	o	o	o	o	o	o	o	o		
EN (10)	o	o			o	x	o	o	o	o	o	o	o	o		
MR (14)	o	x	o	x	o	x	o	x	x	o	o	o	x	o	o	x
BT (13)	o	o	o	o	o	x	o	x	o	o	o	o	x	o		
EM (31)	o			o		o		x	o	o	o	x	o			
IC (20)	o					o		x	o	o	o	o	o	o		
HT (23)	o	o		x		x	o	x	o	o	o	o	o	o	x	x
AD (8)	o			o	o	x	o	x	o	o	o		o		o	o
AT (15)	o					x	o	x	o	o			o		o	
AX (15)	o							x	o							
AW (7)		x				o		x	o							x
AO (14)	x					o		x	o	o	o		o		o	o
AQ (12)	o					o		x	x				o	o	x	o
AE (16)	o					x	o	x	o		o	o	o		o	
AM (11)	o	o				x	o	x	o	o		o	o	o	x	o
AS (6)	o					o	o	x	o	o	o	o	o	o	o	o
TD (15)	o					x		x	o	o	o	o	x		x	o

TABLE 12

RATING, ELEMENT, AND HEAD/BOOK PATTERNS
BY JOB TASK CATEGORIES

Job Task Category	Rating Patterns	Element Patterns
Operate/Secure	Similar	1,2,3,5,16,24,25,29,32
Test/Inspect	Similar (ex: QM, SM,DP,AW)	1-15,18,20-32, Strongly: 1-5,8,9,12-16,20-29,31-32
Adjust/Align	Similar (ex: QM, SM,DP)	All (ex: 19) Strongly: 1-16,20-32
Troubleshoot/Repair	Similar (ex: QM, SM,DP)	All: Strongly
Clean/Lubricate	Mixed	3,5,6,10,16,17,22-25
Remove/Replace	Mixed	2-3,5-7,10,11,14,16,17, 22-27,29,31, Strongly: 5-7,10,11,14,16,17,22,24, 25
Assemble/Disassemble	Mixed	1-3,5-7,10,11,14-17,22,29, 31-32, Strongly: 1-3, 5-7, 10,11,14-17,22,24-27,29

(1) Rating Patterns:
"Similar" = similar K/S elements for ratings (ex = except for)
"Mixed" = mixed K/S elements for ratings; occasional similar patterns

(2) Element patterns: numbers represent K/S elements in which either an "x" or "o" appears on the matrix (Tables 5-11) for at least half the ratings; strongly = an "x" or "o" for at least 75% of the ratings

(3) Head/Book Patterns:
- Ratings (Head): Ratings with at least 75% "x" marks
- Ratings (Book): Ratings with at least 75% "o" marks
- Elements (Head): Elements with "x" marks for at least 75% of the ratings
- Elements (Book): Elements with "o" marks for at least 75% of the ratings

TABLE 12 (cont'd)

RATING, ELEMENT, AND HEAD/BOOK PATTERNS
BY JOB TASK CATEGORIES

	Head/Book Patterns			
	Ratings		Elements	
Job Task Category	Head	Book	Head	Book
Operate/Secure	SM,EW,TM, FTB,MT,RM, DP,EM,IC, AW,AQ,TD	ST,ET,EN, AD,AO,AE, AM,AS	1,24	26,27
Test/Inspect	TM	EN,AO	8,12,14, 16,24	4,7,9,11, 13,17,18, 19,21,23, 25-28,30
Adjust/Align	TM,MR	OS,MT,MM, EN,BT,IC, HT,AD,AT, AX,AO,AE, AM,AS	5-8,10,12, 14,16,24	4,9,11, 13,17,19, 21,23,25, 26,27,30
Troubleshoot/Repair	TM,DP	OS,EN,AM	5,6,8,10, 12,14-16, 18,24,29	4,7,9,11, 13,17,19, 21,23,25, 26,27,30
Clean/Lubricate	OS,TM	EN,AO	5,10,16, 24	7,11,23, 25
Remove/Replace	TM,AQ	EN,AO,AM, AS	5,6,10, 24	11,13,17, 23,26,27, 30
Assemble/Disassemble	DP	AD,AO	5,6,10, 14,16,24	13,17, 23,25,26, 27,30

IV

TENTATIVE TAXONOMY OF GENERIC JOB TASKS

Job Task Categories

The seven main job task categories used in this research were common to the vast majority of technical ratings surveyed. The incidence of identification with these job task categories (i.e., by the vast majority of respondents across virtually every rating) is strong evidence of the applicability of the seven categories to Navy technical ratings generally. This conclusion is supported by the significantly lower incidence of identification with the other three job task categories.

Another piece of evidence in this regard is related to the frequency of performance of job tasks in each category. Among those respondents who reported involvement in each of the job task categories, the percent indicating involvement "often" ranged from 37% to 67% for the seven main categories; and only from 13% to 18%, for the three other categories.

Knowledge/Skill Elements

It is clear from the narrative and tables of Section III that the 32 K/S elements are related to Navy technical job tasks. Each K/S element was identified as important by at least a majority of the ratings in at least three or more of the job task categories.

Since certain K/S elements were reported more frequently than others for the seven main job task categories, it is predictable that the most frequently mentioned K/S elements probably would have the widest application with respect to the full range of Navy technical job task situations.

Figure 2 shows the aggregate counts for each K/S element -- i.e., as reported by ratings across all seven job task categories. These counts, including the division by H/B counts, were calculated from Tables 5-11. The order of K/S elements from highest counts to lowest counts as shown in Table 13 contains few if any surprises. The elements at the top of Table 13 would seem to be basic to <u>any</u> Navy technical job, while those at the bottom (particularly the last ten) would seem to be common only to specific kinds of job tasks -- e.g., testing/inspecting, adjusting/aligning and troubleshooting/repairing. It is understandable therefore why the elements at the bottom would have significantly fewer counts for the <u>total</u> job task categories than those at the top. Nevertheless, the importance of even the latter K/S elements to Navy technical ratings generally is amply substantiated by the vast number of ratings which reported these elements in certain job task categories. To be specific, notice the extensive "x" and "o" distributions for the last ten K/S elements in Table 13 for the job task categories Test/Inspect, Adjust/Align, and Troubleshoot/Repair in Tables 6, 7, and 8 respectively.

Since the 32 K/S elements were identified so frequently by ratings in one or more of the job task categories it seems reasonable to conclude that the K/S elements are probably common to all Navy technical ratings. While the evidence is strong that most of K/S elements used in this research are common to every kind of technical job task performance, others are common mainly or exclusively only to specific kinds of technical job task performance.

FIGURE 2

TOTAL COUNTS OF KNOWLEDGE/SKILL ELEMENTS

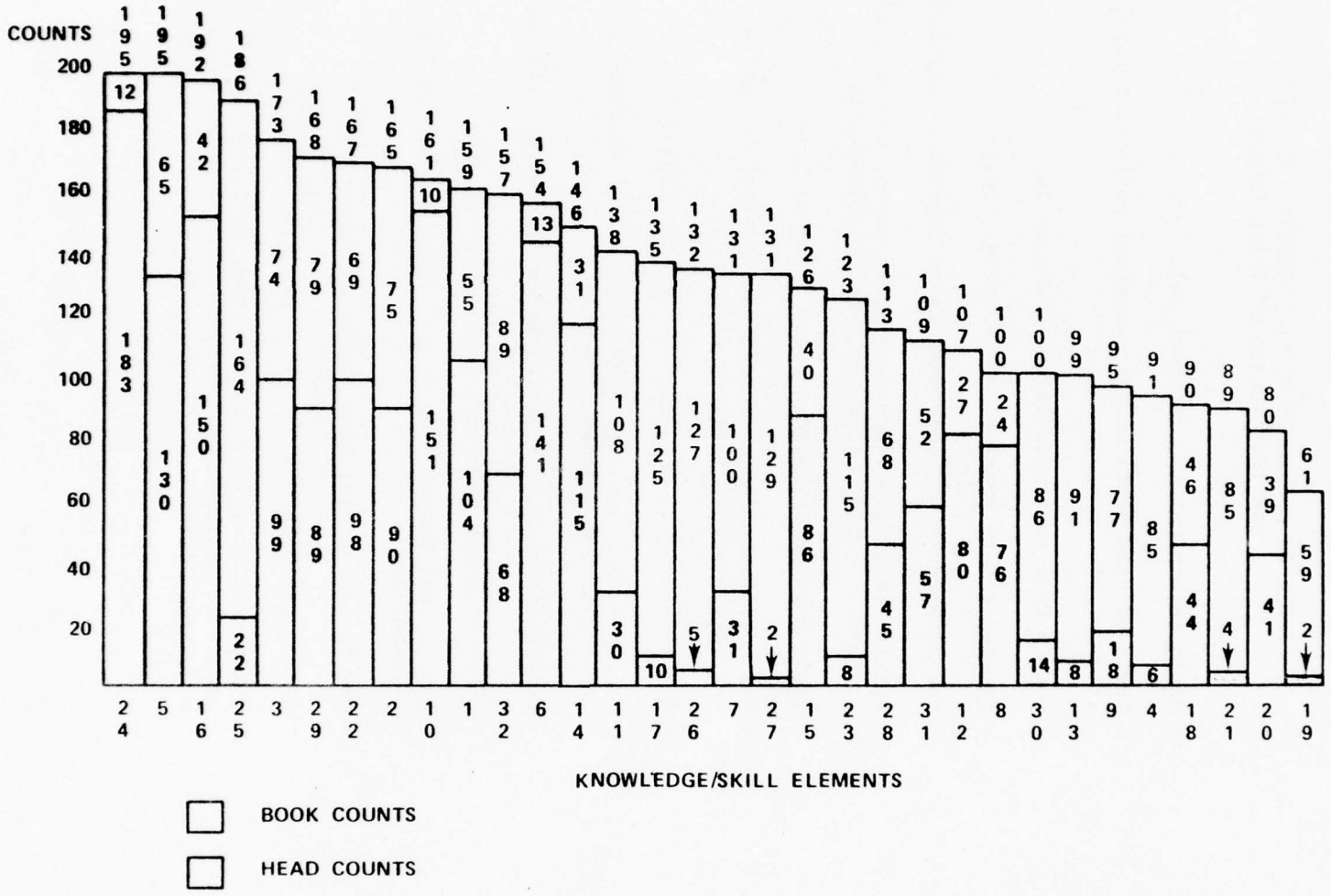


TABLE 13

ORDER OF KNOWLEDGE/SKILL ELEMENTS ACCORDING TO GREATEST NUMBER OF TOTAL COUNTS

- Basic safety rules. (Element 24)
- Names of components and/or component parts in equipment/hardware. (Element 5)
- How to read text materials. (Element 16)
- Special safety precautions, warnings, trips, etc. (Element 25)
- How components and component parts function. (Element 3)
- Special terminology and vocabulary associated with your rating (technical jargon, acronyms, etc.) (Elment 29)
- Basic maintenance procedures. (Element 22)
- How components and component parts relate to entire equipment/ hardware system. (Element 2)
- How to use basic hand tools. (Element 10)
- Theory and/or principles of operation of equipment/hardware and/or its components. (Element 1)
- Skills in how to operate equipment/hardware. (Element 32)
- Names of basic hand tools. (Element 6)
- How to read visual aids (e.g., diagrams, schematics, etc.) (Element 14)
- How to use special hand tools. (Element 11)
- Assembly/disassembly procedures. (Element 17)
- "Visual Information:" e.g., flows, patterns, interconnection of component parts and components, etc. (usually shown on a schematic, diagram, blueprint, sketch, etc.) (Element 26)

TABLE 13 (cont'd)

ORDER OF KNOWLEDGE/SKILL ELEMENTS ACCORDING TO GREATEST NUMBER OF TOTAL COUNTS

- Names of special hand tools. (Element 7)
- Specific calibrations, settings, clearances, voltages, etc. for tools, testing equipment, and/or component parts. (Element 27)
- How to read symbols. (Element 15)
- Special maintenance procedures. (Element 23)
- The meaning of symbols in schematics, drawings, diagrams, prints, etc. (Element 28)
- Ability to differentiate between component parts and components. (Element 31)
- How to use basic testing equipment. (Element 12)
- Names of basic testing equipment. (Element 8)
- Research and reference skills. (Element 30)
- How to use special testing equipment. (Element 13)
- Names of special testing equipment. (Element 9)
- Various formulas, rules, principles, etc. (Element 4)
- Basic troubleshooting procedures. (Element 18)
- Special test equipment procedures. (Element 21)
- Basic test equipment procedures. (Element 20)
- Special troubleshooting procedures (e.g., isolating trouble through a fault logic chart). (Element 19)

Except for K/S elements 31 and 32, which were suggested by a number of respondents at the first Navy activity to complete the questionnaire, no other K/S elements were suggested by respondents. This fact, in addition to the evidence from this research that the 32 K/S elements seem to be common across technical ratings, supports the tentative conclusion that the 32 elements are the major generic K/S pieces of technical job tasks.

Conditions of Performance: Head/Book Implications

Sections II and III discussed the concept of the Head/Book differentiation of factors related to technical job task performance. Head (H) factors referred to K/S elements apparently committed to memory by technicians (i.e., "in the head"); and Book (B) factors to K/S elements requiring some form of technical information presentation (i.e., "in the book"). A H/B analysis of K/S elements in job tasks is essential to defining the conditions of job task performance. The term "conditions" refers to what a technician needs (i.e., information presentation) in order to perform a job task. What he needs, however, will be defined largely by what he has (i.e., a certain knowledge/skill level). In order to specify correctly what he needs, it is essential to determine what he has. To put it another way, what goes "in the book", so far as technical data presentation is concerned, ought to be determined as a result of a careful assessment of what is "in the head" of a technician. An imbalance between H/B factors will result inevitably in misunderstanding and inferior performance.

Certain general conditions of Navy technical job task performance are suggested by the findings of this research. In this regard, the data in Figure 3 and Table 14 serve as a basis for making inferences regarding such conditions. Figure 3 shows the percent of total counts (see Figure 2 for actual counts) which are "H" and "B" counts. Table 14 then lists the K/S elements, in order of highest "H" %/lowest "B" % to lowest "H" %/highest "B" %.

From an analysis of the H/B order shown in Table 14, it was possible to distinguish fairly clear H/B patterns. The "head" pattern revolves around certain fundamental knowledge and skills. It tends to encompass: (1) basic technical nomenclature, terms, jargon, symbols, visual cues, etc., including names of parts and components of equipment/hardware; (2) operating principles, functions, interrelationships, etc. related to parts, components, and system; (3) basic rules/procedures dealing with test equipment, maintenance, and safety; and (4) the names and uses of basic hand tools and test equipment. The kinds of knowledge and skill implied in this pattern should require the least amount (if any) of information presentation at the moment of job task performance.

The "book" pattern revolves around special or more complex knowledge and skills. It tends to encompass: (1) step-by-step procedures; (2) detailed technical information; (3) visual illustrations of functional and operational processes; and (4) the operation of special tools and testing equipment, and of principal equipment/hardware. The kinds of

FIGURE 3

HEAD/BOOK PERCENTAGE DISTRIBUTION
OF TOTAL COUNTS FOR KNOWLEDGE/SKILL ELEMENTS

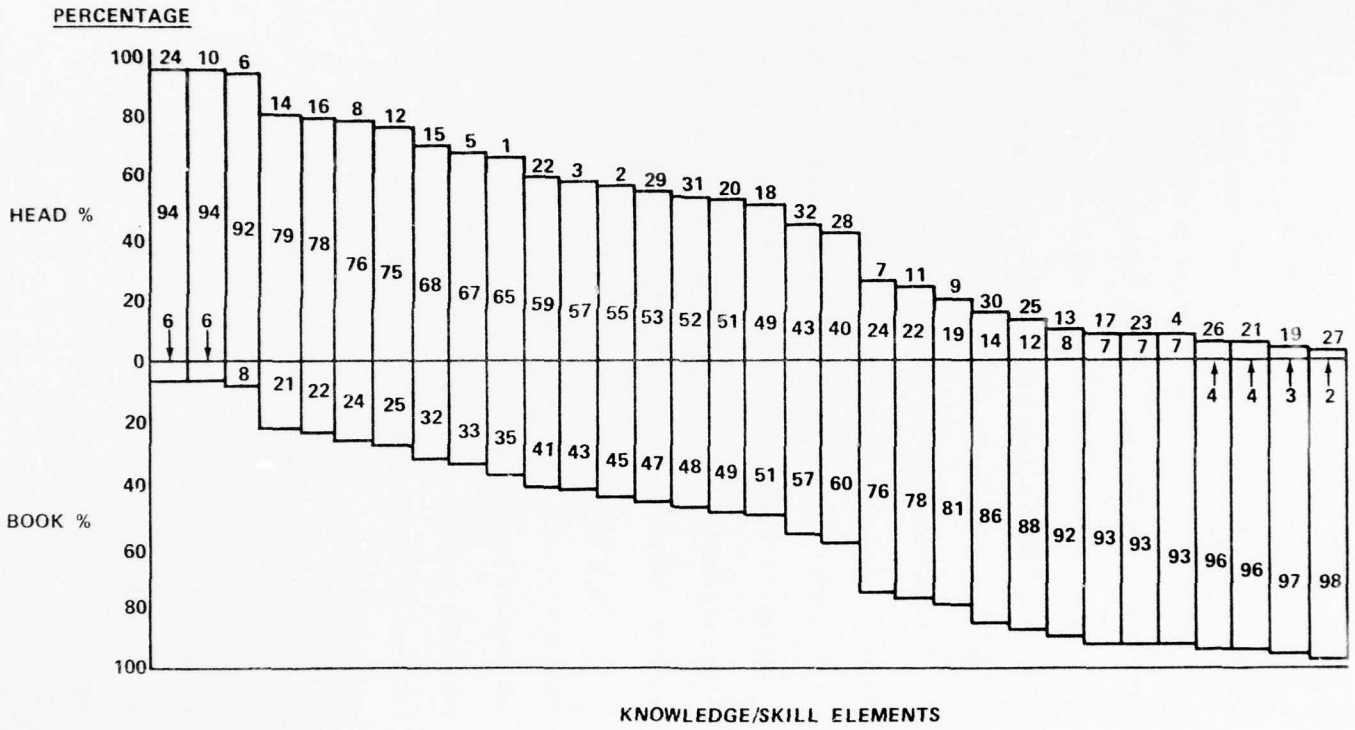


TABLE 14

ORDER OF KNOWLEDGE/SKILL ELEMENTS
ACCORDING TO H/B PERCENTAGES
FROM "HIGHEST H/LOWEST B" to "LOWEST H/HIGHEST B"

- Basic safety rules. (Element 24)
- How to use basic hand tools. (Element 10)
- Names of basic hand tools. (Element 6)
- How to read visual aids (e.g., diagrams, schematics, etc.) (Element 14)
- How to read text materials. (Element 16)
- Names of basic testing equipment. (Element 8)
- How to use basic testing equipment. (Element 12)
- How to read symbols. (Element 15)
- Names of components and/or component parts in equipment/hardware. (Element 5)
- Theory and/or principles of operation of equipment/hardware and/or its components. (Element 1)
- Basic maintenance procedures. (Element 22)
- How components and component parts function. (Element 3)
- How components and component parts relate to entire equipment/hardware system. (Element 2)
- The meaning of symbols in schematics, drawings, diagrams, prints, etc. (Element 29)
- Ability to differentiate between component parts and components. (Element 31)
- Basic test equipment procedures. (Element 20)

TABLE 14 (cont'd)

ORDER OF KNOWLEDGE/SKILL ELEMENTS
ACCORDING TO H/B PERCENTAGES
FROM "HIGHEST H/LOWEST B" TO "LOWEST H/HIGHEST B"

- Basic troubleshooting procedures. (Element 18)
- Skills in how to operate equipment/hardware. (Element 32)
- Special terminology and vocabulary associated with your rating (technical jargon, acronyms, etc.) (Element 28)
- Names of special hand tools. (Element 7)
- How to use special hand tools. (Element 11)
- Names of special testing equipment. (Element 9)
- Research and reference skills. (Element 30)
- Special safety precautions, warnings, trips, etc. (Element 25)
- How to use special testing equipment. (Element 13)
- Assembly/disassembly procedures. (Element 17)
- Special maintenance procedures. (Element 23)
- Various formulas, rules, principles, etc. (Element 4)
- "Visual Information:" e.g., flows, patterns, interconnection of component parts and components, etc. (usually shown on a schematic, diagram, blueprint, sketch, etc.) (Element 26)
- Special test equipment procedures. (Element 21)
- Special troubleshooting procedures (e.g., isolating trouble through a fault logic chart). (Element 19)
- Specific calibrations, settings, clearances, voltages, etc. for tools, testing equipment, and/or component parts. (Element 27)

knowledge and skill implied in this pattern should require the greatest amount of attention in terms of the availability of information presentation at the moment of job task performance.

The conditions of technical job task performance will always be defined for a Navy technician according to some kind of H/B distribution of K/S elements. However, the H/B distribution described above suggests that the usual conditions of technical job task performance are reflected by the technician; (1) having mastered certain rudimentary K/S elements, but (2) usually requiring information presentation for the remaining K/S elements.

Tentative Conclusions

The seven main job task categories are valid descriptions of technical tasks which are generic to Navy technical ratings.

The 32 K/S elements are representative of the main knowledge and skill factors subsumed by these generic job tasks. To perform the job tasks, a technician must deal with the related K/S elements at a number of levels of cognitive behavior. He must recall/recognize an element; comprehend it; and apply the knowledge and skill defined by the element in a job task involving equipment or hardware. At the first level, a technician must either recall an element (committed to memory) or recognize an element presented as technical information (e.g., in a technical manual).

It was possible to group the 32 K/S elements by similar elements so as to form useful classifications of elements. Six classifications

were constructed, and they represent hypothetical descriptions of the range of information required to perform technical job tasks. The classifications are listed below, and K/S elements considered to be contained in each classification are shown parenthetically.

Information Classifications

1. Basic: Nomenclature, terms, codes, jargon, etc. in an occupational specialty, as well as fundamental facts, names, locations, etc. related to parts and components of equipment/hardware; meanings of technical symbols, visual cues, signals, abstract terms, etc. (H Elements: 5, 6, 8, 14, 15, 16, 29, 31; B Elements: 7, 9, 28)

2. Conjoint: Operational principles, functions, relationships, etc. of parts and components of equipment/hardware systems. (H Elements: 1, 2, 3)

3. Operational: Operating steps for simple/basic and complex/special hand tools, testing equipment, and principal equipment/hardware. (H Elements: 10, 12; B Elements: 11, 13, 32)

4. Procedural: Simple/basic and complex/special rules and procedures. (H Elements: 20, 22, 24; B Elements: 4, 17, 18, 19, 21, 23, 25, 30)

5. Multifactual: Lists, tables, etc. containing specific technical data, including descriptive information on calibrations, settings, etc. (B Element: 27)

6. Configurative: Visual representations of functional/operational processes. (B Element: 26)

The approximate order in which the above classifications appear would seem to define lowest-to-highest requirements for technical information presentation. That is to say, the probability of technical information being recalled from memory is greatest for basic and conjoint classifications, and therefore such classifications would seem to have the lowest requirement for information presentation at the time of job

task performance; while multifactual and configurative, the highest requirement.

Notice that H elements tend to cluster in the upper classifications, and B elements in the lower ones. Exceptions to this pattern (e.g., B elements 7, 9, and 28 under "Basic" and H elements 20, 22, and 24 under "Procedural") are explained by the special or basic quality of the elements. More exactly, special names of hand tools and testing equipment usually are not "in the head", while basic procedures usually are.

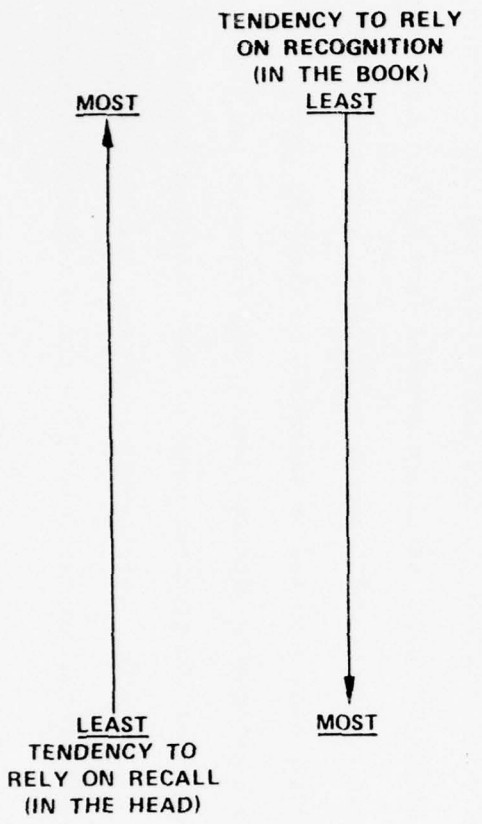
By combining appropriate portions of the three levels of cognitive performance with the six information classifications, it is possible to construct a hypothetical list of cognitive tasks involving the use of technical data. More specifically, such a list can be regarded as a tentative taxonomy of generic cognitive behaviors for technical job tasks. The taxonomy is shown in Table 15.

Such a tentative taxonomy can be hypothesized in light of a number of considerations. In the first place, the information classifications (Basic, Conjoint, etc.) are derived from K/S elements (the 32 used in this research) which appear to be common across Navy technical ratings, -- having been reported as important to three or more of those general job task categories (Operate/Secure, Test/Inspect, etc.) which apparently encompass the greatest range of Navy technical performances.

Secondly, "recalling/recognizing" and "comprehending" are conceptually sound descriptions of levels of cognitive behavior. Based on

TABLE 15

TENTATIVE TAXONOMY OF GENERIC COGNITIVE BEHAVIORS
FOR TECHNICAL JOB TASKS



RECALL/RECOGNITION (AND COMPREHENSION) OF:

- BASIC INFORMATION: NOMENCLATURE, TERMS, CODES, JARGON, ETC., IN AN OCCUPATIONAL SPECIALTY, AS WELL AS FUNDAMENTAL FACTS, NAMES, LOCATIONS, ETC., RELATED TO PARTS AND COMPONENTS OF EQUIPMENT/HARDWARE; MEANINGS OF TECHNICAL SYMBOLS, VISUAL CUES, SIGNALS, ABSTRACT TERMS, ETC.
- CONJOINT INFORMATION: OPERATIONAL PRINCIPLES, FUNCTIONS, RELATIONSHIPS, ETC., OF PARTS AND COMPONENTS OF EQUIPMENT/HARDWARE SYSTEMS.
- OPERATIONAL INFORMATION: OPERATING STEPS FOR SIMPLE/BASIC AND COMPLEX/SPECIAL HAND TOOLS, TESTING EQUIPMENT, AND PRINCIPAL EQUIPMENT/HARDWARE.
- PROCEDURAL INFORMATION: SIMPLE/BASIC AND COMPLEX/SPECIAL RULES AND PROCEDURES FOR ASSEMBLING, DISASSEMBLING, TROUBLESHOOTING, ALIGNING, ETC.
- MULTIFACTUAL INFORMATION: LISTS, TABLES, ETC., CONTAINING SPECIFIC TECHNICAL DATA, INCLUDING DESCRIPTIVE INFORMATION ON CALIBRATIONS, SETTINGS, ETC.
- CONFIGURATIVE INFORMATION: VISUAL REPRESENTATIONS OF FUNCTIONAL/OPERATIONAL PROCESSES.

Bloom's research (see pp. II-3 and II-23), the levels are regarded as part of a valid continuum of cognitive learning by civilian and military education/training establishments alike.

Finally, it is appropriate for any tentative taxonomy of generic tasks performed in conjuntion with technical data to dwell upon cognitive tasks only. The rationale behind such an assertion is that the motory behavior in most technical job task performance consists mainly of highly familiar physical movements. Such motory behavior involves simple movements of the finger, hand, wrist, arm. etc. which have been performed repeatedly in many situations over the years. This conclusion was constantly reaffirmed throughout the study in interviews with Navy technical personnel. Obviously, there are exceptions (e.g., an aviator must learn to coordinate hand and foot movements with respect to simultaneous manipulations of the stick, throttle, and foot pedals of an aircraft), but evidence is sufficiently strong to suggest that most potential problems of technical job task performance will have little or nothing to do with motory capabilities of technicians.

APPENDICIES

ANNOTATED BIBLIOGRAPHY

1. Aagard, James A., and Richard Braby. Learning Guidelines and Algorithms for Types of Training Objectives. Orlando, Florida: Training Analysis and Evaluation Group, Report No. 23, March 1976.

In the process of designing training systems, professionals have been inconsistent in integrating available knowledge and principles on how people learn. Frequently, the translation of psychological learning principles into practices useful for the classroom has not been accomplished, much to the detriment of the instructional program. Since significant training gains can be made through the application of these principles, guidelines which assist the designer in the translation of basic concepts of learning into descriptions of specific action to be taken are needed. To solve this problem, the development of standard guidelines for the structuring of training materials is being seriously examined.

This report summarizes in a simple, readily usable format, the psychological learning principles applicable to the training of common military job tasks. It provides guidance for training system designers in defining basic learning events which reflect research findings on how people learn specific types of tasks. The use of algorithms (in the form of flow charts) to display learning guidelines in a manner that emphasizes the flow of events and the combining and sequencing of learning guidelines in the design of a training program is also demonstrated.

2. Airmen Supply Services Career Field AFSCS 61130, 61150, 61170, 71230, 61250, 61270, 61290, AFPT-90-611-808. San Antonio, Texas: Lackland Military Training Center, Lackland AFB, Job Specialty Survey Division, January 1969.

The document contains a series of job analysis questionnaires to be filled in by supply service personnel as part of an Air Force job survey.

3. Archer, Wayne B. Computation of Group Job Descriptions From Occupational Survey Data, PRL-TR-66-12. San Antonio, Texas: Personnel Research Lab, Lackland AFB, December 1966.

The analysis of occupational survey data is demonstrated in detail, using miniature examples. Beginning with the responses of 10 incumbents to a job inventory consisting of 10 task statements, composite

job descriptions are derived for (A) special groups of incumbents, selected on the basis of background information data: and (B) job type members, identified by an automated job clustering program. Computer outputs from both types of analyses are illustrated and explained.

4. Ausubel, D. P. "The Use of Advance Organizers in the Learning and Retention of Meaningful Verbal Material," Journal of Educational Psychology 1960, 51, 267-272.

The purpose of this study is to test the hypothesis that the learning and retention of unfamiliar but meaningful verbal material can be facilitated by the advance introduction of relevant subsuming concepts (organizers). This hypothesis is based on the assumption that cognitive structure is hierarchically organized in terms of highly inclusive concepts under which are subsumed less inclusive subconcepts and informational data (Ausubel, Robbins, & Blake, 1957). If this organizational principle of progressive differentiation of an internalized sphere of knowledge does in fact prevail, it is reasonable to suppose that new meaningful material becomes incorporated into cognitive structure in so far as it is subsumable under relevant existing concepts. It follows, therefore, that the availability in cognitive structure of appropriate and stable subsumers should enhance the incorporability of such material. If it is also true that "meaningful forgetting" reflects a process of memorial reduction, in which the identity of new learning material is assimilated by the more inclusive meaning of its subsumers (Ausubel et al., 1957), the same availability should also enhance retention by decelerating the rate of obliterative subsumption.

In the present study, appropriate and relevant subsuming concepts (organizers) are deliberately introduced prior to the learning of unfamiliar academic material, in order to ascertain whether learning and retention are enhanced thereby in accordance with the theoretical premises advanced above.

5. Baker, E. L., and W. J. Popham. Systematic Instruction. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1970.

This book deals with the nature of instruction. For those preparing to be instructors the text will serve as an introduction to the kinds of considerations associated with instruction. For already experienced instructors, the text provides a vehicle for reexamining general instructional strategies and particular teaching tactics.

6. Banathy, Bela H. Instructional Systems. Belmont, California: Fearon, 1968.

In this book, recommendations are presented for the use of the systems approach in designing curriculum. In curriculum construction, there are variations in levels and complexities. This book discusses the use of simple system development strategies on an introductory level.

7. Bilinski, Chester R., John C. Saylor, and Lloyd S. Standlee. Training Feedback on the AN/WRC-1 Radio Set, SRR-72-5. San Diego, California: Naval Personnel and Training Research Lab, August 1971.

A job analysis was made of the maintenance requirements of the AN/WRC-1 radio set. 155 items--including a few 'knowledge' items--were grouped into 35 checklist/card sort/interview items. The items were administered by a research team visiting ships at Long Beach and San Diego, with the total sample including about 20 per cent of all West Coast ships having the AN/WRC-1 radio set. When combined with a depth interview about performance, 'knowledge' items appear to be a fruitful source of information about performance difficulties. Grouping of maintenance tasks was compared to treating each task as a separate item.

8. Bloom, B. S. "Learning for Mastery." In B. S. Bloom, J. T. Hastings, and G. F. Madaus (Eds.) Handbook on Formative and Summative Evaluation of Student Learning. New York: McGraw-Hill, 1971.

Most students can master what we have to teach them, and it is the task of instruction to find the means which will enable them to master the subject under consideration. A basic task is to determine what we mean by "mastery of the subject" and to search for methods and materials which will enable the largest proportion of our students to attain such mastery.

This work considers one approach to learning for mastery and the underlying theoretical concepts, research findings, and techniques required. Basically, the problem of developing a strategy for mastery learning is one of determining how individual differences in learning and learners can be related to the learning and teaching process.

9. Briggs, Leslie J. Sequencing of Instruction in Relation to Hierarchies of Competence. Pittsburgh, Pa.: American Institutes for Research, 1968.

Since the acquisition of knowledges and skills takes place in a cumulative fashion over periods of time, it is relevant to consider how different portions of the learner's time might best be spent. Experimental investigations directed to this end have dealt with the matter of varying the sequencing of the component parts of the instructional materials and noting the effects upon learning. While practically all investigators believe that some arrangements of material with respect to sequencing the instruction should be more effective than others, the theoretical rationales for this belief vary greatly. The purpose of this report is to review the research literature regarding sequencing of instruction in terms of the rationales employed, the experimental procedures followed, and the results and their apparent implications.

10. Briggs, Leslie J. Student's Guide to Handbook Procedures for the Design of Instruction. Pittsburg, Pennsylvania: American Institutes for Research, 1972.

The handbook is organized as a teaching program. It is designed to develop competence in the utilization of the model which has ten components:

1. State objectives and performance standards.
2. Prepare tests over the objectives.
3. Analyze objectives for structure and sequence.
4. Identify assumed entering competencies.
5. Prepare pretests and remedial instruction.
6. Select media and write rescriptions.
7. Develop first-draft materials.
8. Conduct small group tryouts and revisions.
9. Conduct classroom tryouts and revisions.
10. Evaluate performance.

This model provides for some flexibility, as frequent alternative approaches are suggested. In addressing the development of objectives, the author utilizes Mager's approach.

11. Bruner, J. S., J. J. Goodnow, and G. A. Austin. A Study of Thinking. New York: Wiley, 1956.

This book is an effort to deal with one of the simplest and most ubiquitous phenomena of cognition categorizing or conceptualizing. It does not offer "explanation" in terms of learning theory, information theory or personality theory, but rather describes what happens when an intelligent human being seeks to sort the environment into significant classes of events, so that he may end by treating discriminably different things as equivalents.

12. Browning, Robert F., John K. Lauber, and Paul G. Scott. Task Analysis of Pilot, Copilot, and Flight Engineer Positions for the P-3 Aircraft, TAEG Report 7. Orlando, Florida: Training Analysis and Evaluation Group, Naval Training Equipment Center, July 1973.

The report provides a task analysis of the pilot, copilot, and flight engineer positions in the P-3 aircraft and delineates the method employed in translating task analysis data into an improved training system. It identifies the behavioral activities of the pilot, copilot, and flight engineer during normal, abnormal, and emergency operations. It contains a method for translation of task analytic data into syllabi, lesson guides, and lesson plans.

13. Butterworth, Robert Martin. Task Analysis of U. S. Navy Enlisted Radiomen With Emphasis on Technical Controllers at the U. S. Communications Station, San Francisco, California. Unpublished Master's Thesis. Monterey, California: Naval Postgraduate School, March 1973.

The report summarizes occupational analysis conducted in the United States, placing particular emphasis on the efforts of the military services. It presents an explanation of current task analysis procedure and computer programs used by the U. S. Navy in its occupational research. And, it describes how such methodology was used to conduct a task analysis of U. S. Navy enlisted radiomen. The results of that study are presented. It is concluded that further task analysis of U. S. Navy enlisted radiomen is desirable to improve organizational efficiency and the effectiveness of training.

14. Chambers, Armand N. Development of a Taxonomy of Human Performance: A Heuristic Model for the Development of Classification Systems, Technical Report. Pittsburgh, Pa.: American Institutes for Research, October 1969.

The need for better classification systems to understand and apply the vast amounts of data about man's performance of jobs and tasks has been expressed by many workers in the behavioral sciences and human factors technologies. However, reviews of existing classification systems, reported in previous technical reports in the series, disclosed more expressions of needs for these systems than actual systems in existence.

Therefore, as a means for more systematically exploring the issues and options with respect to the further development of human performance classification systems, a heuristic model is presented in this report. With this as a framework, the uses of human performance

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classification systems, their content, and the methods available for their development and verification are each discussed in turn. Two important and relatively distinct uses of classification systems emerge from an analysis of this model--namely, their use as aids in information retrieval and in scientific generalization and prediction.

15. Christal, Raymond E. CODAP: Input Standard (INPSTD) and Variable Generation (VARGEN) Programs. San Antonio, Texas: Air Force Human Resources Lab, Lackland AFB, Personnel Division, May 1972.

The report was written to acquaint occupational analysts, occupational research personnel, and personnel managers with the functions and utilities of CODAP, a comprehensive set of occupational data analysis programs. The report describes and gives example applications for the Input Standard Program (INPSTD) and the Variable Generation Program (VARGEN).

16. Christal, Raymond E., and Johnny J. Weissmuller. New CODAP Programs for Analyzing Task Factor Information, AFHRL-TR-76-3. San Antonio, Texas: Air Force Human Resources Lab, Brooks AFB, May 1976.

The comprehensive Occupational Data Analysis Programs (CODAP) package is a highly interactive and efficient system of computer routines for analyzing, organizing, and reporting occupational information. Until recently, CODAP contained approximately thirty-five main programs for analyzing data collected with job inventories to produce task-level descriptions of the work performed by individuals and groups of individuals. It also contained programs for identifying and describing the types of jobs existing in an occupational category, and for describing the characteristics of individuals falling into special or job-type groups. The new programs described in this paper represent a major addition to the CODAP system, filling an important gap by equipping the analyst with tools for addressing new problem areas. In addition to describing the eight new programs in detail and showing how they interact with existing programs, the paper provides an example demonstrating how the new programs can be used to develop and apply an equation which assigns training priorities to tasks in an occupational area based upon consideration of relevant task factor information.

17. Clary, James N. Naval Occupational Task Analysis Program Data Bank Information: Its Use in the Development/Updating of Qualifications for Advancement, WTR-73-32. Washington, D.C.: Naval Personnel Research and Development Lab, June 1973.

The Naval Occupational Task Analysis Program (NOTAP) is concerned with the development of a multi-purpose occupational data bank. This study is concerned with the analysis of data bank information and with demonstrating the feasibility of using such information to develop and/or update the qualifications for advancement of navy enlisted personnel. Methodologies for determining the validity of tasks for inclusion in the qualifications for advancement are described. It appears that the use of data bank information may preclude the necessity for separate rating surveys as are currently conducted.

18. Cory, Charles H. A Comparison of the Job Performance and Attitudes of Category IVs and I-IIIs in 16 Navy Ratings, NPRDC-TR-76-35. San Diego, California: Navy Personnel Research and Development Center, May 1976.

As an aid to the appropriate assignment of category IV personnel to navy ratings, this study was intended to provide objective data on the performance abilities of IVs in a representative sample of ratings. Supervisory evaluations, biographical information, and attitude data were collected on samples of IV and non-IV personnel in 16 navy enlisted ratings. Comparisons of IVs and non-IVs in each rating were made in terms of job performance, personal characteristics, and attitudes. T tests were used to identify the distinguishing characteristics of high performing IVs in five ratings. Multiple-regression analyses were used to investigate the predictability of performance of category IVs in three ratings. In the ratings covered, IVs exhibited generally widespread but small deficits in on-job performance when compared with non-IVs. Deficits in the global performance of IVs were generally statistically significant for the boiler technician, machinery repairman, and quartermaster-signalman ratings/rating groups. Test scores and educational attainment were associated with high on-job performance of IVs.

19. Crawford, Meredith P. "Concepts of Training." In Robert M. Gagne (Ed.) Psychological Principles in System Development. New York: Holt, Rinehart and Winston, 1966.

The concepts presented in this chapter concern both the process of training and the application of techniques of research and development to that process. The discussion is limited to the training of individuals.

For purposes of this discussion, training is defined as that process by which individuals learn the knowledges, skills and attitudes, not previously in their repertories, which will fit them to function as human components in a system. This training may take place in a

school, before the individual is a member of the system, or on the job, after he has become a human component within it. Major attention is devoted to formal training given before the man enters the job although some consideration will be given to on-the-job training. It is recognized, although not discussed in this chapter, that the individual will continue to modify his behavior even after he has reached a minimum level of competence on the job. This improvement in performance is, in part at least, a function of the individual's learning to interact with other members.

20. Davies, Ivor K. The Management of Learning. London: McGraw-Hill, 1971.

Many books on education and training set out, in effect, to tell teachers and instructors how they should do their job. This book has not been written from this standpoint. It is not a cookbook of recipes for all occasions and all seasons. The aim of this book on the management of learning is to give teachers and instructors useful and valid criteria against which they can choose alternative courses of action in light of the assumptions they make about teaching, the objectives to be realized, the resources available and the character of the students involved. In this sense, the book is designed to cater for the needs of lecturers, teachers, and administrators (who control the purse strings), working in the area of secondary and tertiary education; instructors involved in industrial and military training programs; and staff working in management training. Students undergoing teacher training and post-graduate courses in education and educational technology will also find the material particularly relevant to their studies.

21. Davis, Robert and Richard A. Behan. "Evaluating System Performance in Simulated Environments." In Robert M. Gagne (Ed.) Psychological Principles in System Development. New York: Holt, Rinehart and Winston, 1966.

The purposes of system evaluation as seen in this chapter, are to make possible a prediction of the system's capability to perform its major and alternative missions, to compare these performances with those of other systems designed to accomplish a similar mission, and to develop the doctrines of system usage which will optimize its performance. Such purposes can best be achieved by broad-scale employment of simulation techniques, which make it possible to represent the inputs to the system, the conditions of its employment, the environment within which it is designed to function, and thus to permit the collection of data providing valid conclusions about system operations.

The approach to system evaluation described here has many close resemblances to scientific experimentation. The analysis of problems to be studied, the design of techniques of experimental control, the selection of performance criteria, and the formulation and testing of specific hypotheses, all display formal similarities to those occurring in the more familiar setting of the scientific laboratory. The design and control of studies for system evaluation pose some challenging methodological questions, particularly when one conceives of the entities of study as crews performing integrated system functions, rather than as mere collections of individuals.

22. DeCecco, John P., and William R. Crawford. The Psychology of Learning and Instruction. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1974.

This book provides a general conception or model of teaching which is useful in describing and analyzing instruction and a body of knowledge which is useful in the description of instructional objectives in the accommodation of the entering behavior of individual students, in the selection of instructional materials and procedures, and in the assessment of performances. It provides a theoretical and factual basis for making teaching decisions and specific guidelines for important teaching functions.

23. DuBois, P. H., and G. D. Mayo (Eds.). Research Strategies for Evaluating Training, AERA Monograph Series on Curriculum Education, No. 4. Chicago: Rand-McNally, 1970.

This monograph is divided into 3 sections: basic issues in training research, measurement of learning, and method and results. The first section discusses the strategy of research and some theory of learning and human ability. Section two deals with the criterion problem in measurement, reliability of the measuring instrument, and the relation between two measures of learning. The final section, called method and results, discusses types of analysis and design, as well as the relationship between learning and intelligence.

24. Fitts, P. M., and M. I. Posner. Human Performance. Belmont, California: Brooks/Cole, 1967.

Before we can understand the complexities of human performance, there must be a unified framework for studying it. This book seeks to aid the reader in creating that framework, by specifying the capacities that man brings to the performance of intellectual and physical skills.

It discusses the limits of man's ability to sense, attend to, process, store and transmit information. By seeking always for the simpler components within complex skills, it points toward an understanding of human performance that allows discussion of complicated and practical tasks. Each chapter builds upon ideas and techniques introduced in earlier chapters. Arguments are closely tied to the results of experimental studies.

25. Foley, John P., Jr. Some Key Problems Concerning the Specification, Development and Use of Task Identification and Analyses, AFHRL-TR-76-57. San Antonio, Texas: Air Force Human Resources Lab, Brooks AFB, July 1976.

This paper concerns the problems involved in the development and use of task identification and analyses (TI and A) as a required part of the technologies of task (JOB) oriented training (TOT) and job performance aids (JPA). Such analyses are also required for optimum TOT/JPA tradeoffs. It stresses the fact that training which has the flavor of TOT and JOB guides which have the appearance of fully proceduralized JPA (FPJPA) can be produced without TI and A. However, the content of such training and job aids will be uncontrolled and likely incomplete. The usability of various formats of TI and A products as well as the special analyses required for troubleshooting (TS) aids are also discussed.

26. Gagne, Robert M. "Domains of Learning," Interchange. 1972, 3, 1-8.

This article discusses 5 different categories of learning processes: (a) motor skills learned by practice, (b) verbal information which has to be presented within an organized meaningful context in order to be learned, (c) intellectual skills to be learned only after appropriate prior learning, (d) cognitive strategies which are learned on the basis of repeated occasions in which challenges to learning are presented, and (e) attitudes as are primarily learned from other people. Research evidence suggests that generalizations about both the conditions and outcome of learning can be validly made within these categories but not across them.

27. Gagne, Robert M. "Human Functions in Systems." In Robert M. Gagne (Ed.) Psychological Principles in System Development. New York: Holt, Rinehart and Winston, 1966.

This chapter attempts to describe and categorize the basic types of human functions which are known and differentiated by psychologists.

These are the "information-processing" functions of man, which are generally agreed to divide themselves into the three major categories of sensing, perceiving, and thinking. These are here given the names of sensing, identifying, and interpreting, in order to more certainly imply their operational definitions. The attempt is made to represent these human functions and their interrelationships by means of flow diagrams, and to provide a rationale for doing so. Using such a representation, it becomes possible to consider the bases for limitations in human functioning and to draw some instructive comparisons and contrasts between the functions of man and machine.

28. Gagne, Robert M., and Leslie J. Briggs. Principles of Instructional Design. New York: Holt, Rinehart and Winston, 1974.

This book describes both the derivation and application of methods which can be used to design topics, courses, and lessons of instruction in a variety of subjects, based upon principles of human learning and performance analysis. These methods are also related to the design and evaluation of instructional systems. An introductory chapter contains a background of learning principles on which the design of instruction will be based and includes a brief overview of the contents of succeeding parts. Chapter 2 defines and illustrates the major classes of learning outcomes for programs of instruction, including intellectual skills, information attitudes, motor skills, and cognitive strategies. Chapters 3 and 4 describe the conditions of learning applicable to the acquisition of these capabilities.

In Part 2, which describes methods of designing instruction, Chapter 5 deals with procedures for defining learning outcomes. The following Chapter 6 provides an account of procedures for determining sequences of instruction applicable to courses and to curricula. Chapter 7 introduces some general principles for the design of instructional events at the level of the lesson, and Chapter 8 deals with practical procedures for the arrangement of effective learning conditions in the design of single lessons. The topic of assessing student performance is taken up in Chapter 9.

In Part 3, Chapter 10 describes the larger framework of instructional design in terms of a complete system as might be adopted by a school system. The employment of procedures for individualized instruction in such a system is detailed in Chapter 11. A final Chapter 12 deals with procedures for the evaluation of programs of instruction.

29. Gagne, Robert M. "Learning and Communication." In R. V. Wiman and W. C. Meierhenry (Eds.) Educational Media: Theory and Practice. Columbus, Ohio: Merrill, 1968.

This chapter focuses on the varieties of communication that are involved in the specific functions of instruction. The varieties of communication that enter into the process of education, globally conceived, continue to be of fundamental importance to any more narrowly defined component of the educational system. Recent developments, for example, have seen a heavy concentration of effort on curriculum, in mathematics, science, social studies, English, and many other areas. It is apparent that consideration of the outcomes of these efforts, and their effects on the total system, raises questions about educational objectives which properly involve the channel of communication between educators and the adult public. The design of curricula represents only one channel of communication, but the objectives which are sought inevitably interact with other channels when the system of education is viewed as a totality.

30. Gagne, Robert M. The Conditions of Learning, 2nd Ed. New York: Holt, Rinehart and Winston, 1970.

The point of view of this text is that learning must be linked to the design of instruction through consideration of the different kinds of capabilities that are being learned. In other words, the external events that are called instruction need to have different characteristics, depending on the particular class of performance change that is the focus of interest.

The book describes eight distinguishable classes of performance change (learning) and the corresponding sets of conditions for learning that are associated with them.

31. Glaser, Robert. "Components of the Instructional Process." In J. P. DeCecco (Ed.) Educational Technology. New York: Holt, Rinehart and Winston, 1964.

The author forsees the development of an educational technology based on stimulus response psychology and the experimental findings of the psychology of learning. Glaser has developed a curriculum model that conveniently depicts the parts and interrelationship of parts in an educative process. He calls his model an "instructional system" and proceeds to explain system objectives, system input, system operator, output monitor and research and development logistics.

32. Glaser, Robert. "Psychological Bases for Instructional Design," Audiovisual Communications Review, Vol. 14, No. 4, Winter 1966, 433-449.

If it can be agreed that the science of psychology must supply the knowledge for the precepts of instruction, then it follows that the translation of scientific knowledge into practice requires technological development. However, this requires the existence of an educational technologist or instructional designer. The book suggests a framework in which such a professional would work.

In instructional design, the components of the framework are (a) analyzing the characteristics of subject matter competence, (b) diagnosing preinstructional behavior (c) carrying out the instructional process and (d) measuring learning outcomes. This paper makes further comment about each of these.

33. Harrow, Anita J. A Taxonomy of the Psychomotor Domain. New York: David McKay, 1972.

This text has as its broad concern the provision of a model which can be utilized by educators to assist them in becoming more efficient in organizing their instructional goals and to better evaluate achievement of learning concerned with cognitive, affective, and psychomotor behaviors. The specific intent of this text is to provide a functional written taxonomy for the psychomotor domain to be utilized for the classification of observable movement behaviors. The classification levels within the model are hierarchically arranged along a continuum from the lowest level of psychomotor behavior to the highest level. This taxonomy will make it possible for educators to identify and classify behaviors unique to the psychomotor domain. It will act as a guide for educators concerned with preparing a meaningful sequential curriculum utilizing appropriate instructional strategies, and selecting relevant measurement techniques. Working with this type of a framework, educators will be able to make possible more meaningful experiences focused upon improved psychomotor development of children.

The following strategies were utilized to develop this model for classifying movement behaviors of children. The movement literature was thoroughly reviewed. The categorizations of movement components advocated by various authors were studied and compared to ascertain similarities which might prove beneficial to the evolving taxononomy. Pertinent definitions were collected, compared, selected and modified where necessary to provide a common base upon which to develop this functional model.

34. Hubbs, E. M. Glossary of Action Verbs Used in Naval Occupational Analysis. Washington, D.C.: Naval Personnel Research and Development Lab, January 1971.

The action verbs contained in the glossary are provided for use by occupational analysts and other individuals who are responsible for defining tasks, duties, skills, and knowledges required of navy officers and enlisted men.

35. Interservice Procedures for Instructional Systems Development, 5 Phases, NAVEDTRA 106A. Pensacola, Florida: Chief, Naval Education and Training, August 1975.

The five phases represent a coordinated direction by the Armed Services toward systematically carrying out education and training programs. The phases support an ISD framework as follows: Phase I: Job Analysis, including selecting task/functions, constructing job performance measures, analyzing existing courses, and selecting the instructional setting; Phase II: Developing Objectives, including developing tests, describing entry behavior and determining sequence and structure; Phase III: Specifying Learning Events/Activities, including specifying the instruction management plan and delivery system, reviewing/selecting existing materials, developing instruction, and validating instruction; Phase IV: Implementing the instructional Management Plan, including the conduct of instruction; and Phase V: Conducting internal, as well as external, evaluation, and revising the system.

36. Johns, Bev, John Kern, and C. Koch. Military Occupational Information Data Bank, Vol. 1, Operational Guide, ORI-TR-508-VOL-1. Silver Spring, Maryland: Operations Research, Inc., November 1968.

The Military Occupational Information Data Bank (MOIDB) is a total operating system with the capability of providing military job information on army-wide basis. It collects field data, provides computerized processing and storage, and permits retrieval of information on military jobs in the army. The information is based on actual field data and includes frequency of performance of various tasks by duty position, the equipment used, the knowledges required to perform the tasks, and the special requirements of the MOS.

37. Johnson, Mark E. Job Analysis: An Assessment of Applicability of Analysis Systems of Other Services to Navy Enlisted Billets, WRM-67-9. Washington, D.C.: Naval Personnel Program Support Activity, Personnel Research Lab, November 1966.

As a basis for approaching the development of a navy job analysis system, the standard procedures in job analysis are analyzed and reviewed, together with recent developments in the field. Limitations Upon the research are identified, and some of the underlying assump-

tions are indicated. Criteria for a navy job analysis system are proposed. Industrial and governmental practices in job analysis are discussed, particularly the systems followed by the U. S. Marine Corps, the U. S. Air Force, and the U. S. Army, and their use for navy purposes is appraised. Procedures followed by the U. S. Department of Labor are also examined. It is concluded that, while certain aspects of the air force and marine corps job analysis systems may pertain to the navy, a job analysis system which is satisfactory for the navy must be developed to accommodate the navy's unique characteristics and requirements.

38. Johnson, Mark E. Job Analysis: Selecting the Type of System for Navy Use, WRM-67-23. Washington, D.C.: Naval Personnel Program Support Activity, Personnel Research Lab, February 1967.

The principal objective of this report is to design and develop a multi-purpose occupational analysis system. The system will provide current, accurate, detailed information for users of occupational data, and will also serve as a basis for further studies in associated fields of personnel management. In the phase of the study reported here, methods of occupational analysis used by other military services and the Department of Labor, reported previously, are reviewed briefly and appraised in terms of their applicability to navy billets. A method for developing an occupational analysis system suitable to the navy is proposed. It employs the most recent advances in the techniques of collecting, analyzing, storing and retrieving occupational information. The method proposed calls for the establishment of a computerized occupational data bank, and for the use of billet inventories in the collecting of occupational information. The report recommends that the proposed method be used to conduct an occupational analysis of the boatswain's mate and radioman ratings, and that this work be considered as a pilot test of the method for its subsequent application to all navy enlisted billets.

39. Johnson, Mark E., and Roy B. Wethy. Occupational Analysis: Design of a System for Navy Use, WRM-69-22. Washington, D.C.: Naval Personnel Research and Development Lab, Personnel Systems Research Department, May 1969.

The report describes the design, development and pilot test of procedures for an occupational analysis system suitable for navy use. Sample print-outs, tables, and charts reflecting end products of the system are presented. A navy-wide field test of the system under operating conditions is recommended as a step in establishing a navy occupational data bank.

40. Kempf, Rodney Paul. The Collection and Analysis of Human Factors Data in Task Analysis. Unpublished Master's Thesis. Monterey, California: Naval Postgraduate School, April 1970.

The paper develops a questionnaire to be used in determining the necessity of various human factors to the successful performance of any particular job. Included in the proposed questionnaire are fifty-eight characteristics and a scheme for rating the variables. A program is developed for analyzing the data collected. A two-way analysis of variance by ranks is used to detect significant difference between the characteristics, and, given a difference exists, a method similar to the multiple range test is employed to separate the several characteristics into significance groups, the various groups being ranked on an ordinal scale.

41. Kendler, Howard H. "The Concept of the Concept." In A. W. Melton (Ed.) Categories of Human Learning. New York: Academic Press, 1964.

Initially the methods used to investigate concept learning have been examined, particularly in terms of how the empirical attacks upon this problem have been shaped by theoretical preconceptions. An attempt is made to tease out significant characteristics of these approaches so that some overview, although no doubt an incomplete one, is offered of the current scene of research and theory in the field of classificatory behavior. Finally, the problems of conceptual behavior are systematized in terms of stimulus-response language. For the most part this analysis is concerned not with criticism but with clarification, not with truth but with meaning.

42. Kennedy, John L. "Psychology and System Development." In Robert M. Gagne (Ed.) Psychological Principles in System Development. New York: Holt, Rinehart and Winston, 1966.

Psychologists carry out research and development on the human components, subsystems, and total system interactions of man-machine systems. They give advice, based upon psychological facts and principles, about design interventions in systems, about measuring the performance of man-machine systems, and about improving the performance of systems. In rare instances, they may actually manage the process of development of man-machine systems. They are specialists in "human engineering," personnel selection, training, "human factors," and other applied arts connected with the development of systems. This chapter contains a brief discussion of these activities in relation to the concept of systems as developing organisms.

All these activities lead to the conception of an even more fundamental and important enterprise, that of utilizing the concept of man-

machine system as a framework for the organization and definition of problems of basic research on human behavior. The design and conduct of fundamental research to extend our understanding of system development is an activity which exhibits great promise for the understanding of human behavior as it occurs in socially important and productive situations. These possibilities are discussed in the latter portion of this chapter, where we consider the man-machine system and its development as an arena for psychological research, and give an account of the methods employed in such research. Some of the major implications of this approach for the definition of psychological problems are also considered.

43. Kraemer, R. E. Crew Duties and Tasks for Operation of the M551. Alexandria, Virginia: George Washington University Human Resources Research Office, March 1968.

This document provides job task descriptions for crew operation of the M551 vehicle, and describes the sequence of task elements necessary in performing each task. It collates and delineates all vehicle-related tasks required in operation by the vehicle crew. The material will serve as a partial basis for research analyzing training requirements for the main battle tank (MBT-70).

44. Krathwohl, D. R., B. S. Bloom, and B. B. Masia. Taxonomy of Educational Objectives, Handbook II: Affective Domain. New York: David McKay Co., 1964.

This volume, dealing with the affective domain, is a follow-up of Taxonomy of Educational Objectives, Handbook I: Cognitive Domain.

The authors have developed a classification scheme for organizing categories of affective objectives. The categories are arranged in a hierarchy along a continuum of internalization from lowest to highest.

45. Kuriloff, Arthur H. Principles of Training in Marine Corps Task Analysis. Training Manual 1, TR-7. Los Angeles, California: California State University Los Angeles, December 1975.

This is the first in a series of five training manuals developed for use by the office of manpower utilization, Hq., USMC (OMU) in its task analysis program. This initial manual is designed for trainers of OMU staff members assigned to the Task Analysis (TA) program. The objectives of this training manual are: (1) to recommend procedures and training materials for minimizing the time required to orient and train new task analysis team members; (2) to increase the period of time

new staff members will be productive on a TA team by shortening the indoctrination and training period; and (3) to upgrade skills for increasing the effectiveness and productivity of experienced as well as new members of TA teams. The initial section of this training manual discusses individual competencies required for task analysis and qualifications for TA research. Motivation for training and learning is reviewed and recommendations to stimulate learning are made.

46. Lane, Gene L., and Clarence T. Marshall. Occupational Analysis: Final Report on the Design of a Navy Officer Occupational Analysis System, WTR-73-31. Washington, D.C.: Naval Personnel Research and Development Lab, June 1973.

The report summarizes an exploratory development effort in the design and development of a navy officer occupational analysis system. It describes the design and content of the Combat Information Center (CIC) officer data gathering instrument (task inventory), administration procedures, and computer processing of the data. Sample analyses of the derived data are presented as examples of military usefulness, and the methodology is critiqued. The CIC officer task inventory and sample computer printouts are included as appendixes.

47. Mager, Robert F., and Kenneth N. Beach, Jr. Developing Vocational Instruction. Palo Alto, California: Fearon, 1967.

Developing Vocational Instruction is designed to aid both the skilled craftsman who is preparing instruction through which to teach his craft, and the experienced vocational or technical instructor who is interested in improving his present course or finds it necessary to prepare a new one. It is designed to help develop instruction in a vocational or technical field, according to procedures developed in the research laboratory and tested in the classroom. The authors' assumption is that the vocational instructor is interested in turning out graduates who can perform effectively on the job, and that he is also interested in being able to demonstrate his success at doing so.

48. Mager, Robert F. Preparing Instructional Objectives. Palo Alto, California: Fearon, 1962.

This book deals with skills in specifying objectives in terms of observable performances. Not only does the book provide a valuable approach to the task of goal-specification, but it also supplies an orientation that views goal-specification as an unavoidable, practical problem requiring hard-headed solutions.

49. Mattox, Walter Charles, Jr. Job Dimension Analysis of Naval Communications Managers. Unpublished Master's Thesis. Monterey, California: Naval Postgraduate School, March 1973.

A study of naval officers assigned to communications management billets was conducted to determine job requirements of those billets. The executive position description questionnaire developed by Hemphill was used for the study. Analyses of data from 114 respondents to the questionnaire were conducted. Respondents were grouped into seven categories according to job type, and a mean score was computed for each of Hemphill's dimensions. Cluster analysis was used to develop six dissimilar clusters maximizing similarities among respondents within clusters.

50. Mecham, Robert C., and Ernest J. McCormick. The Rated Attribute Requirements of Job Elements in the Position Analysis Questionnaire, No. 1. Lafayette, Indiana: Purdue University Occupational Research Center, January 1969.

The report describes one phase of a research program which is, in part, directed toward synthetically establishing job requirements by the use of a structured job analysis format and the rated attribute requirements of each of the job elements comprising the format. The phase described in this report involved: (1) the selection of human attributes relevant to job performance; (2) the obtaining of ratings of the relevance of those attributes to the job elements of the position analysis questionnaire; (3) the analysis of the reliability of such ratings; and (4) the derivation of attribute requirements profiles for the individual job elements on the basis of several sets of ratings.

51. Menig, John R., and Thomas A. Ranney. B-1 Systems Approach to Training. Sorting Model for B-1 Aircrew Training Data. User's and Programmer's Guide, CALSPAN-TM-SAT-4. Buffalo, New York: Calspan Corp., July 1975.

This report describes how the sorting model can be used to store, retrieve, and update aircrew task analysis and control/display data. The user's guide gives the details necessary to run the program; the programmer's guide supplement describes the program logic.

52. Merrill, M. D. "Paradigms for Psychomotor Instruction." In M. D. Merrill (Ed.) Instructional Design: Readings. Englewood Cliffs, New Jersey: Prentice-Hall, 1971.

This paper discusses process behavior and shaping as they relate to psychomotor instruction. Psychomotor instruction is designed to

enable the learner to exhibit specified psychomotor behavior in response to particular stimulus situations. The basic acquisition of psychomotor behavior is dependent on the basic learning processes of discrimination, generalization and chaining. Since psychomotor instructional paradigms are procedures which are designed to promote the attainment of particular process behaviors, they also are designed to include the learning processes described.

53. Merrill, Paul F. Task Analysis - An Information Processing Approach, CAI-TM-27. Tallahassee, Florida: Florida State University Tallahassee Computer-Assisted Instruction Center, April 1971.

Several concepts and techniques used to design computer simulation of human performance were used in developing an information processing approach to task analysis. This new approach was compared and contrasted with Gagne's hierarchical task analysis model. Neither hierarchical nor information processing analysis would be sufficient for all types of tasks. A hierarchical analysis would be appropriate where lower ordered skills generate positive transfer to higher level skills, while an information processing analysis would be utilized where the output of one task subskill or operation is required as input for a succeeding operation.

54. Meyer, Robert P., Jack I. Laveson, Neal S. Weissman, and Edward E. Eddowes. Behavioral Taxonomy of Undergraduate Pilot Training Tasks and Skills: Executive Summary, AF-1123. St. Louis, Missouri: Design Plus, December 1974.

The report summarizes the development and application of a behavioral taxonomy of undergraduate pilot training (UPT) tasks and skills. The taxonomy specifies the fundamental flying abilities which comprise the training objectives of UPT. Its purpose is to provide a broadly applicable conception of UPT that obviates the need to continually study each specific training task or aircraft to determine the requirements for training hardware and software in research on and the development of optimized flying training programs.

55. Mitchell, John F., William M. Hinton, Jr., and Steven L. Johnson. B-1 Systems Approach to Training. Behavioral Objectives for the Pilot, Copilot, and Offensive Systems Operator, Vol. 1, CALSPAN-TM-SAT-2-VOL-1. Buffalo, New York: Calspan Corp., July 1975.

The systems approach to training (SAT) for the B-1 aircrew involves the transformation of task analysis data into complete and precise statements of all behaviors necessary to carry out the B-1 mission.

The resulting behavioral objectives delineate the 'who, what, how, when and how well' of each definable behavior. A compilation of behavioral objectives for the pilot, copilot and offensive system operator is contained in this report, preceded by a brief description of the procedures for their development.

56. Mitchell, John F., William M. Hinton, Jr., and Steven L. Johnson. B-1 Systems Approach to Training. Behavioral Objectives for the Pilot, Copilot and Offensive Systems Operator, Vol. 2, CALSPAN-TM-SAT-2-VOL-2. Buffalo, New York: Calspan Corp., July 1975.

Volume 1 contains introductory information and mission segments 1-15. Volume 2 contains mission segment 16 and emergency procedures.

57. Mitchell, John F., and Thomas A. Ranney. B-1 Systems Approach to Training. Task Analysis Listings, CALSPAN-TM-SAT-7. Buffalo, New York: Calspan Corp., July 1975.

The primary mechanism for automated data maintenance for the B-1 systems approach to training (SAT) is the sorting program. The data upon which the sorting program operates consist of two interacting components, the task analysis data and the control and display catalog. This technical memorandum consists of two computer reports which represent the essential information in the task analysis data base.

58. Moore, Brian E. Occupational Analysis for Human Resource Development: A Review of Utility of the Task Inventory. Austin, Texas: Texas University at Austin Center for Cybernetic Studies, April 1976.

A review of the issues concerning the field of occupational analysis is undertaken in this paper in order to indicate the comparative strengths and weaknesses of the task inventory. Specifically, the significance of the task inventory (TI) will be assessed for: (1) reliability and validity; (2) job analysis and evaluation; (3) occupational restructuring and career ladder development; and (4) manpower planning. Particular attention is placed on the comprehensive Occupational Data Analysis programs (CODAP) originally developed by the air force as it is applied in the navy civilian models for organization design and staffing (MODS) system.

59. Morsh, Joseph E., and Wayne B. Archer. Procedural Guide for Conducting Occupational Surveys in the United States Air Force, PRL-TR-67-11. San Antonio, Texas: Personnel Research Lab, Lackland AFB, September 1967.

The procedural guide sets forth in detail the procedures for collecting, organizing, analyzing, and reporting information describing work performed by air force officers and airmen. Specific steps in the application of the air force method of job analysis are presented in chronological order. The guide has been designed to (a) provide guidance to air force and other agencies who propose to construct and administer job inventories, (b) assemble information about the air force method of job analysis which is now available only from scattered sources, (c) indicate problems found in applying the air force method and suggest possible solutions, (d) summarize hitherto unreported experiences gained during occupational surveys, (e) acquaint using agencies with products of occupational surveys, and (f) provide briefing material where summary information about the air force method is required.

60. McCormick, Ernest J., Paul R. Jeanneret, and Robert C. Mecham. A Study of Job Characteristics and Job Dimensions as Based on the Position Analysis Questionnaire. Lafayette, Indiana: Purdue University Occupational Research Center, June 1969.

It was hypothesized that, across the spectrum of jobs, there is some underlying 'structure' of human work in terms of the human behaviors involved. The project was directed toward the identification of behavioral job elements and of their organization into job dimensions, and the exploration of certain possible practical applications of job data based on such job elements or dimensions. The project involved the development of a job analysis instrument called the position analysis questionnaires (PAQ) that included 189 job elements of a worker-oriented nature. Principal components analysis procedures were used in the analyses of two types of data based on the PAQ. One set consisted of job data for 536 jobs that were analyzed with the PAQ. The other consisted of 'attribute profiles' of the job elements; (these consisted of median ratings of the relevance of 67 human attributes to each job element).

61. McCluskey, Michael R, T. O. Jacobs, and Fred K. Cleary. Systems Engineering of Training for Eight Combat Arms MOSs, HUMRRO-TR-74-12. Alexandria, Virginia: Human Resources Research Organization, June 1974.

The basic objective of this project was to develop task inventories and job task data for duty positions in eight of the key combat arms MOSs using systems engineering procedures. Field validation by job incumbents, senior NCOs, and officers resulted in a complete definition of each duty position in an MOS in terms of common and noncommon tasks at various levels of organization. The information on commonality of tasks that is contained in this report and the by-product report may be

directly utilized by curriculum planners, training administrators, and training developers at each of the combat arms schools.

62. Naylor, J. C., and G. E. Briggs. "Effects of Task Complexity and Task Organization on the Relative Efficiency of Part and Whole Training Methods," Journal of Experimental Psychology 1963, 65, 217-224.

Task complexity (2 levels), task organization (independence of task dimensions - 2 levels) and training method (whole vs. progressive-part) were combined factorially in an 8-group transfer of training study of skill in a Markov prediction task. A hypothesized interaction of the 3 independent variables was supported by the data, thus suggesting the following training principle: for a relatively highly organized (integrated) task, a whole-task training method should be superior to a part schedule at all levels of task complexity; however, for a relatively unorganized task (all task dimensions independent), an increase in task complexity will result in a part-task training schedule becoming superior to whole training.

63. Payne, D. A. The Specification and Measurement of Learning Outcomes. Waltham, Massachusetts: Blaisdell, 1968.

This book has a singular purpose: to provide the ever increasing number of classroom teachers with a practical and efficient set of techniques to aid in evaluating student achievement. The essential principles of educational and psychological measurement are presented along with many concrete examples. Abbreviated but valid statistical techniques will be described, highlighting their application in improving test analyses and interpretation. The main theme and focus, however, will be on content related to test and item construction and development of principles useful in measuring the "cognitive" outcomes of education.

The first five chapters of this brief volume deal with essentially pretest activities. Learning outcomes are identified, stated operationally, and items are written to measure them. It is also at this point that decisions about the administration and scoring of the instrument(s) are made. Testing then takes place. Chapters 6 through 8 are then concerned with summarizing test data, deriving meaning for both group and individual scores, and analyzing both the test and its items. With increasing frequency schools and to some extent individual teachers are using standardized achievements tests to assist in evaluating learning outcomes. Topics related to the types of instruments available, and the relative advantages and disadvantages in using these kinds of tests are treated in Chapter 9. The book closes by taking a brief look at the always perplexing problem of marking. The problems are highlighted and techniques that may be used in grade assignment are presented.

64. Phalen, William J. Occupational Survey of the Data Systems Career Field (68XX0), AFHRL-TR-70-11. San Antonio, Texas: Air Force Human Resources Lab, Lackland AFB, Personnel Research Division, May 1970.

An occupation survey of the data systems career field was conducted. The survey instrument was a job inventory consisting of a background information section and 511 task statements grouped under 14 duty categories.

65. Popham, W. J., and E. L. Baker. Establishing Instructional Goals. Englewood Cliffs, New Jersey: Prentice-Hall, 1970.

This book consists of a collection of five self-instruction programs. The programs deal with various aspects of instruction and are intended to provide a set of tangible competencies that can be employed by an instructor in making instructional decisions. The focus of the programs in this volume is on the topic of instructional goals: how to select them, how to state them, and how to establish student performance standards for such goals.

66. Ranney, Thomas A., and Anndrea J. Blair. B-1 Systems Approach to Training. Control and Display Catalog and Action Verb Thesaurus, CALSPAN-TM-SAT-8. Buffalo, New York: Calspan Corp., July 1975.

For the B-1 systems approach to training (SAT), the primary mechanism for the automated data maintenance is the sorting program. The data upon which the sorting program operates consists of two interacting components, the task analysis data base and the control and display catalog. A thesaurus of action verbs functions as a user interface with the task analysis data. This memorandum consists of four computer-generated reports, the first three of which represent the essential information in the control and display catalog. The fourth report is a listing of the action verb thesaurus. These reports are current as of the date of this document. Revised lists can be reported at any time by the users of the sorting program.

67. Ring, William F. H., Walter L. Stortz, George Gaidasz, and John R. Menig. B-1 Systems Approach to Training. Training Resources Analytic Model (TRAM). User's Manual, CALSPAN-TM-SAT-5. Buffalo, New York: Calspan Corp., July 1975.

The tram is a multiphase set of computer programs which model a proposed training system and determines resource utlization, scheduling problems and costs. Each program is described by a user's guide and programmer's guide. Also indicated is the relationship of TROLIE, the quick-look version of TRAM, which was developed. Phase 1 of the TRAM

is used to assemble most of the input data and to check it for consistency and completeness. The Phase 2 program further checks linkages and network integrity and prepares lists of names, student demands, trainee source lists and resource lists. Phase 3 resolves the trainee demands into classes and determines the amount of resources used by simulating the training system. Phase 4 computes the amount of resources used by comparing the unused and original resources, and then prepares an economic analysis of the run.

68. Ring, William F. H., George Gaidasz, John R. Menig, and Walter L. Stortz. B-1 Systems Approach to Training. Training Resources Analytic Model (TRAM). Programmer's Manual, CALSPAN-TM-SAT-6. Buffalo, New York: Calspan Corp., July 1975.

This programmer's guide is intended to supplement the user's guide. The purpose of Phase 1 is to assemble most of the data and to check it for consistency and completeness. Phase 2 makes further checks on linkages and network integrity. Phase 2 prepares lists of names, student demands, trainee source lists and resource lists. Phase 3 resolves the trainee demands into classes and determines the amount of resources used by simulating the training system. Phase 4 computes the amount of resources used by comparing the unused and original resources, and then prepares an economic analysis of the run. Phase 5 processes the trainee source and LAG records and writes a report on these uses. TROLIE is a quick-look version of Phases 1, 2 and 3 of TRAM which can be used for less detailed analysis.

69. Sample, Clarence A., and Melvin S. Majesty. Operational Tasks Oriented Flying Training Program for Pilot Training: The Systems Approach. Canoga Park, California: Bunker-Ramo Corp., January 1969.

The purpose of the study was to take a fresh and independent look at flying training requirements unhampered by the current training program and the traditional approach. The report presents a systems methodology for determining knowledges and skills common to piloting tasks required by differing aircraft-missions for the purpose of structuring a data base from which an operational tasks oriented flying training program could be developed. The general approach was to identify and classify the specific tasks performed by USAF pilots and the level of proficiency required on teach task for successful performance in current and projected assignments in operational units using present and projected aircraft. The study was planned to encompass cross-system analysis and the integration of pilot tasks data into the air force human resources laboratory's computer based data bank. Therefore, inqueries across and within aircraft systems pertaining to piloting tasks, training requirements, and performance standards would be possible. Criteria for establishing common mission segments, tasks and

cockpit subsystem hardware are presented. The technique for analying common tasks is presented in relation to assumptions regarding the type of training programs to which the data could apply. Rules for describing task activities and preparing the data for insertion into the computer based data bank are given.

70. Sanders, Mark S., John J. Jankovich, and Phillip R. Goodpaster. Task Analysis for the Jobs of Train Conductor and Brakeman, NAD-CR-RDTR-263. Crane, Indiana: Naval Ammunition Depot, July 1974.

The document describes the results of a research effort undertaken to detail the tasks of freight train conductors and brakemen. Included with text are detailed operational sequence diagrams for both conductor and brakeman.

71. Shriver, Edgar L., and John P. Foley, Jr. Evaluating Maintenance Performance: The Development and Tryout of Criterion Referenced Job Task Performance Tests for Electronic Maintenance. Falls Church, Virginia: URS/Matrix Research Co., September 1974.

This volume reports the development of a battery of criterion referenced job task performance tests (JTPT) for typical electronic maintenance activities, together with an appropriate scoring scheme for reporting the results of administering them. The development of a test administrators handbook also is described. This battery is considered to be a model for future criterion JTPT development and is intended for both formal training and field use. The battery includes separate tests for the following classes of job activities: (1) equipment checkout, (2) alignment/calibration, (3) removal/replacement, (4) soldering, (5) use of general and special test equipment, and (6) troubleshooting. The doppler radar, the AN/APN-147 and its computer the AN/ASN-35 were selected as a typical electronic system. This system was used as the test bed for this model battery. The soldering and general test equipment JTPT are applicable to all electronic technicians. The other tests of the battery apply to technicians concerned with this specific doppler radar system.

72. Silverman, Joe. New Techniques in Task Analysis, NPRA-SRM-68-12. San Diego, California: Naval Personnel Research Activity, November 1967.

The research is directed toward the investigation of recent developments in techniques of task analysis. Because of methodological problems associated with the development of training curricula, the analysis of man-machine systems, and occupational analysis, it has been

proposed that a task taxonomy be developed. Such a taxonomy would indicate the inherent similarities between tasks, independent of their environment, and pave the way for improvements in training, billet structure developments, and improved manpower utilization. There have been numerous attempts at developing task taxonomies--both quantitative and qualitative.

73. Singer, R. N. Readings in Motor Learning. Philadelphia, Pennsylvania: Lea and Febiger, 1972.

This book attempts to indicate the present state of our knowledge in the area of motor learning, and at the same time, demonstrates the need for more research on all skilled types of behavior. Each section or chapter of the book is preceded by introductory material to familiarize the student with the nature of the given topic. An overview of each article is also excluded to emphasize further its major points and values.

74. Skinner, B. F. The Technology of Teaching. New York: Appleton-Century-Crofts, 1968.

This book consists of essays, lectures and original material that express the author's views on teaching as they have developed over the last fourteen years. Skinner's name has been associated with teaching machines, programmed instruction and operant conditioning. Instead of punishment (aversive control) operant conditioning is used to teach (train, educate, reenforce) the subject to produce the required behavior.

75. Stewart, Joseph David. The Usefulness of Task Analysis in the Evaluation of Military Training. Unpublished Master's Thesis. Monterey, California: Naval Postgraduate School, September 1970.

Determining the proper emphasis of curriculum contents as well as judging the value or worth of training programs has become an important problem. The purpose of the paper is to demonstrate the usefulness of task analysis in measuring the effectiveness of training courses based on the extent to which curriculum contents are job oriented. In this regard, parametric and nonparametric statistical procedures are discussed as well as a matrix method of evaluation. A general methodology to include the operational significance of the data is also included. In addition, the results of a small scale experiment to determine the most valid questionnaire associated data collection method are given.

76. Stoehr, Leonard A., and Barbara Paramore. Handbook for the Development of Qualifications for Personnel in New Technology Systems, ORI-TR-1012. Silver Spring, Maryland: Operations Research, Inc., June 1976.

An established method of task analysis -- functional job analysis -- has been adapted for use in delineating qualifications needed by personnel in new types of vessel systems. The method was developed and applied in two demonstration projects, from which qualifications were recommended for liquefied natural gas cargo handling personnel and nuclear ship engineering personnel. The procedures address special problems involved in performing a generally applicable analysis that reflects the unique hazards and safety requirements of marine occupations. The report on the method is in handbook form. It covers definition of the new type of system, data sources, development of an analytic structure, the writing of complete task descriptions within a system function framework, and procedures for supporting the reliability and validity of the task data produced in the analysis.

77. Swann, James H. Interpretation and Training Uses of Computer Printout Data of Naval Occupational Task Analysis Program (NOTAP), WTR-73-34. Washington, D.C.: Naval Personnel Research and Development Lab, June 1973.

The investigation is concerned with the interpretation of Navy Occupational Task Analysis Program (NOTAP) computer printout data in terms of its use in the design and development of navy training programs, courses, and curricula. The study interprets NOTAP data and shows how it may be used most effectively in the design and development of training programs to insure that the policy of the chief of naval training is implemented. Namely, 'that all navy training be based upon a thorough and meticulous analysis of the duties and tasks to be performed by the trainee, to the end that all navy training is job-relevant'. Examples of a training program design and a format for a job/task analysis based curriculum are presented, and some recommendations are made.

78. Theologus, George C., Tania Romashko, and Edwin A. Fleishman. Development of a Taxonomy of Human Performance: A Feasibility Study of Ability Dimensions for Classifying Human Tasks, AIR-726-1/70-TR-5, R70-1.

The report describes a series of studies carried out to develop methods by means of which observers can describe tasks in terms of their ability requirements. The general objective was to provide an instrument which could be utilized to describe both laboratory and operational tasks along a comprehensive set of specifically defined ability dimensions.

79. Thorndike, R. L., and E. W. Hagm. Measurement and Evaluation in Psychology and Education. New York: Wiley, 1969.

This book is one of the few comprehensive texts in educational and psychological measurement. Chapters 1 and 2 present some of the history and philosophy of measurement. Chapters 3 and 4 are relevant to the planning and preparation of teacher made tests. Chapter 5 is an introduction to statistical method with content appropriate for a measurement course. Chapter 6 treats the validity, reliability and practical aspects of testing. Chapter 7 contains discussion of norms and measurement units. Chapter 8 describes sources of information useful in selecting tests. Chapter 9 in discussing standardized achievement tests contrasts them with teacher made tests. Chapters 10 and 11 are devoted to the measurement of intelligence or scholastic aptitude. Chapters 12 - 15 cover a variety of types of measurements and evaluation. Chapter 16 deals with the planning of testing programs on all levels. Chapter 17 treats of marks and marking in ways that should promote their reliability and validity, and Chapter 18 is on measurements in educational and vocational guidance.

80. Traweek, John H., and Walter E. Driskill. Specialty Survey of the Tele-Communications Systems Control Career Ladder 307X0. San Antonio, Texas: Lackland Military Training Center, Lackland AFB, Job Specialty Survey Division, April 1969.

An occupational survey of the tele-communications systems control career ladder was conducted on 197 tasks grouped under seven duties, plus a background information section consisting of 97 history variables. In completing the inventory, each incumbent supplied identification and biographical data and checked the tasks which were part of his regular job. He then rated the tasks he had checked on two 7-point scales. The computer then generated composite job descriptions, made up of tasks performed, for groups of incumbents defined in terms of background variables. In the printout, the tasks are listed in descending order of time spent on them. Job descriptions are also published which show descending order of time spent on duties.

81. Tyler, L. E. The Psychology of Human Differences, 3rd Ed. New York: Appleton, Century-Crofts, 1965.

In this book, human differences are viewed from a practical as well as theoretical point of view. The discussion is opened with considerations of the field of differential psychology to include philosophical and historical considerations, a section dealing with the general principles and concepts and an explanation of research strategies. The major dimensions of individual differences are discussed in terms of

intelligence, school advancement and achievement, special aptitudes and talents, personality, interests and values and cognitive style. Dealing with group differences are chapters on sex, age, race, social class, the mentally retarded and the gifted. A final section involves the relationships between the factors producing differences.

82. Vineberg, Robert, and Elaine N. Taylor. Performance in Four Jobs: The Role of Mental Ability and Experience, HUMRRO-Professional Paper-31-70. Alexandria, Virginia: Human Resources Research Organization, December 1970.

The paper is based on data from work unit utility research on job performance of men at different ability levels. The paper deals with data testing performance in four jobs: armor crewman, vehicle repairman, supply specialist, and cook, of various Armed Forces Qualification Test (AFQT) levels over specified periods of time.

83. Warnick, William L. Combat Job Requirements for the Air Cavalry Aeroscout Pilot and Aeroscout Observer, HUMRRO-TR-72-37. Alexandria, Virginia: Human Resources Research Organization, December 1972.

The objectives of the research were to formulate and describe the skills and knowledges required for combat job performance for the aeroscout pilot and aeroscout observer in an air cavalry unit, and to determine how much emphasis should be placed on each skill or knowledge area during training. Job inventory lists were administered to 14 combat-experienced aeroscout pilots and 15 aeroscout observers. The respondents judged each skill or knowledge item in terms of its importance for job performance in combat. This information provides a basis for organizing content and subject emphasis of formal training programs, and provides school personnel and field commanders with a basis for evaluation and development of such.

84. Whaton, George R., Angelo Mirabella, and Alfred J. Farina, Jr. Trainee and Instructor Task Qualification: Development of Quantitative Indices and a Predictive Methodology. Pittsburgh, Pa.: American Institutes for Research, January 1971.

An exploratory study was undertaken as part of a program to develop quantitative techniques for prescribing the design and use of training systems. As a first step in this program, the present study attempted to: compile an initial set of quantitative indices; determine whether these indices could be used to describe a sample of trainee tasks and differentiate among them; develop a predictive methodology based upon the indices; and assess that methodology using studies in the

literature. The compilation included the display-evaluative index, a set of panel lay-out indices, and a set of task rating scales. These indices were applied to task analytic data, collected on sonar operator trainers at Fleet Sonar School, Key West, Florida. Application of the indices proved feasible, and differentiation among three training devices, and within four trainee sub-tasks (set-up, detection, localization, classification) was possible. The predictive method which was generated was an adaptation of the standard multiple regression model. Mean task scores replaced the usual individual criterion scores, and quantitative task index values were used as predictor scores. This adaptation was tested using data from published studies on tracking.

85. Wiley, Llewellyn N, William S. Jenkins, Leland P. Cagwin, and Harry M. Kudrick. Job Types of Communications Officers, DAFSC 3034, PRL-TR-66-17. San Antonio, Texas: Personnel Research Lab, Lackland AFB, November 1966.

A job inventory was constructed to cover the tasks of the communications officer, DAFSC 3034. This inventory was administered to all available communications officers and officers in closely related activities during the spring of 1962. Of the 1,204 inventories analyzed, 1,043 were completed by officers in DAFSC 3034. Others were completed by officers in related specialties. Tasks were checked only if they were performed by the respondents. Task grouping analysis resulted in 19 job types. Two of these, comprising 189 and 90 officers, were quite similar to DAFSC 3034 officers as a whole, and a third type of 80 officers emphasized the maintenance aspect of the specialty. Smaller distinct job types could be readily recognized and given appropriate job titles.

14 September 1976

From: T. E. Powers
To: R. A. Sulit

Subj: Trip Report to Service School Command, U. S. Naval Training Center, Great Lakes, Illinois dated 23-27 August 1976

1. Purpose

The purpose of the visit was to gather some preliminary information about job tasks performed with the use of technical data. More specifically, it was the intent of the visit to obtain information concerning:

1. the nature of tasks which require the use of technical data to perform.

2. the kinds of mental and physical elements related to the performance of a job task involving the use of technical data.

3. the kinds of mental and physical prerequisite skills required to perform a job task with the use of technical data.

The overall goal was to determine the kinds of questions to be asked in subsequent surveys of job tasks involving the use of technical data. The survey questionnaires and follow-up interviews were intended to elicit the kind of information which would be useful in developing a more thorough and exact survey/interview schedule for future data-gathering efforts related to job tasks involving the use of technical data.

2. Personnel Contacted:

1. CAPT W.A. Lamm, C.O., Service School Command, Great Lakes
2. CDR R.M. Burman, X.O., Service School Command, Great Lakes
3. CAPT R.J. O'Malia, Director, Propulsion Engineering School, SSC GLakes
4. LCDR Sadler, Ass't Director, Propulsion Engineering School, SSC GLakes
5. Mr. Hale K. Darling, GS-11, Training Specialist, Prop. Eng. Sch., SSC GLakes
6. LT Brian Edwards, Engineering Officer, 1200 psi boiler, PE Sch., SSC GLakes
7. LT J.W. Norris, Em/IC Schools, SSC GLakes
8. CWO2 L.W. Smith, EM/IC Schools, SSC GLakes
9. GMCM J. W. Webb, Curriculum Instruction Standards Office, SSC GLakes
10. Twenty-Five (25) enlisted personnel (6 BTs, 6 MMs, 5 EMs, 5 ICs, 2ENs, 1 MR), E5 - E9

3. Discussion and Findings:

Twenty-five officers were initially surveyed in groups of about five. Each was asked to describe any job task in his rate which required the use of technical data for job task performance. Since this encompassed virtually every kind of job task a petty officer normally performs in maintenance/operation situations, the petty officers were told, in addition, to select a job task with which they were particularly familiar and which was representative of job tasks frequently performed. This was done in writing on a form provided (see Attachment 1).

Having thus described a job task from his rate, each petty officer was then asked to complete two forms which dealt with specifying certain mental and physical characteristics related to the performance of that job task. The first of these was entitled "Physical and Mental Characteristics Used in Meeting Job Requirements", and it was taken in total from the Job Task Analysis inventory for BT's, MM's, EN's, EM's, and IC's developed by the Navy Occupation Task Analysis Program (NOTAP). See Attachment 2 to this report for a sample inventory.

In using the "Physical and Mental Characteristics Used in Meeting Job Requirements", each petty officer was told to circle any characteristic which was needed to perform the job task he described. Then, for every item circled he was asked to indicate the importance of that characteristic on a five-step scale ranging from "very important" to "almost unimportant".

The second form (see Attachment 3) consisted of eleven kinds of performance tasks which might be required in performing a job task. These eleven tasks, and the examples, were developed by the Training Analysis and Education Group (TAEG), Orlando, Florida, from concepts from the Interservice Procedures for Instructional Systems Development.

In using the TAEG Performance Tasks, each petty officer described how particular performance tasks listed pertained to the job task he had previously described. Obviously, only those performance tasks which were appropriate to the job task described were selected by each petty officer. The intent in using two survey forms was thoroughness, and any occasional duplication between items on each form was seen as desirable in checking the face validity of responses.

Each petty officer also filled out a brief personal information sheet (Attachment 4). This procedure made it possible to keep track of the respondents for any subsequent survey/interview work.

After the survey forms were completed by each group of petty officers, an interview was conducted privately with each petty officer for about 45-60 minutes. Two principal questions were explored as follows:

1. With respect to the job task you have described, why is technical data needed by you to perform that job task? In other words, what would you be looking for in a technical manual, without which you could not perform the job task described?

2. With respect to the job task you have described, what kinds of knowledge and skills would a technician have to have in order to perform that job task using a technical manual? That is to say, even with technical data available to assist the technician, what prerequisite competencies must a petty officer have to perform the job task?

The pursuit of these two questions in the order indicated was intended to provide some information concerning the best mix of head/book (TM) essentials for performing a job task. Additional questions in the interview were related to each petty officer clarifying some of the responses made on the two survey forms.

Results

Since the purpose of the surveying/interviewing at Great Lakes was to gather certain preliminary information regarding job tasks performed with technical data for survey questionnaires and interview schedules for future field work, no attempt is made to report specific findings. Therefore, the findings reported below are purposely kept general and broad at this time.

(i) Survey Forms

From the list of "Physical and Mental Characteristics Used in Meeting Job Requirements" (Attachment 2), petty officers tended to select the same kinds of characteristics when asked to identify those needed to perform the job task each had described. This was true regardless of rating -- although it should be stressed that the N by ratings was insufficient for any reliable across-ratings comparisons. However, Table 1 illustrates that where at least a majority of total respondents selected a particular physical or mental characteristic, in most cases a majority of the respondents in each rating also selected that characteristic. The obvious implication is that there might be greater similarity than dissimilarity among ratings with respect to basic characteristics of job tasks.

Table 2 suggests that any differences among ratings with respect to physical and mental characteristics of tasks might be more of a function of the "degree of importance" of the same characteristic than a large number of discrete characteristics per se by ratings. Table 2 was developed as a result of weighting the "degree of importance" (see Attachment 1) from 5 down to 1 (i.e., "very important" - 5 . . . "almost unimportant" - 1), and then calculating an aggregate score for each rating and for the total respondents on each characteristic. Those characteristics with a weighted score above the median score for any rating and for the total are listed by number in Table 2. The check (X) indicates an aggregate score which exceeded the median, and as such identifies characteristics seen by the respondents as being of average-to-great importance to performance of the job task described by them. Again, no real conclusions are warranted from such a small sample; nevertheless, Table 2 does suggest that ratings can be differentiated by degrees of importance for certain physical and mental characteristics held in common among job tasks for various ratings.

In selecting those "Performance Tasks" (see Attachment 3) related to the job task described, the petty officers surveyed again showed consistency in their selection. That is to say, regardless of rating, they tended to identify (or not identify) the same performance tasks as being involved in performing the job task that each had described. Table 3 shows the number of respondents by ratings who selected each performance task.

(2) Interviews

As previously stated, the main purpose of the individual interviews was to elicit from each respondent what ought to be in the TM (book) and what ought to be in the technician (head) in order to perform the task described by each respondent. The results of following this procedure were generally favorable, and a considerable amount of information regarding a head/book balance in job task performance was obtained. Again, regardless of ratings, there was general consistency in responses regarding what a technician should know/do from memory and what he should find/recognize in a TM to perform the job task described.

The critical importance of the interviews was that they provided more perspective regarding the elements, and their arrangements, which make up the two major components (i.e., "head" and "book") which must come together in proper balance. The common thread among the five ratings investigated was that most of the elements mentioned by respondents as needed "in the head" to perform the job task they described could be categorized under "general knowledge and skills"; while those needed "in the book", under "specific directions".

Tentative General Conclusions

1. It is possible to identify elements of job task performance. Respondents had little difficulty in applying the concepts related to the NOTAP task inventory and TAEG performance tasks to the job tasks described.

2. There appears to be similar elements, in terms of physical and mental characteristics required for performance, among job tasks. This assertion, however, does not deny the existence of elements which might be peculiar to a particular job or to a particular rating. However, a significant number of respondents tended to cluster on characteristics used in the survey which had to do with physical attributes, cognitive/sensory discrimination, and environmental idiosyncrasies. Similarly, respondents tended to cluster around performance tasks having to do with recalling bodies of knowledge, rule learning and using, making decisions, detecting, identifying symbols, and recalling procedures/positioning movements.

3. Although job tasks across ratings may contain a high proportion of similar elements, such elements might vary by ratings in their "degree of importance".

4. There seems to be general agreement about what a technician should find "in a book" (i.e., contained in the TM) and what he should have "in his head" (i.e., prerequisite knowledge/skills) in performing a job task. Responses to the "in the head" question took the form of general knowledge and skills, and included such specifics as: theory of operation; knowledge of names, functions, and locations of components; knowledge of symbols; ability to read drawings and schematics; physical characteristics; names and uses of tools; knowledge of general safety rules; etc. Responses to the "in the book" question took the form of specific directions, and included such specifics as: disassembly, repair, assembly procedures; specification of calibrations, settings, clearances, etc.; troubleshooting steps (symptoms, causes, remedies); accompanying schematics, drawings, pictures; parts lists; specific safety information; etc.

What will be important to subsequent research on Navy job tasks will be the use of information obtained in this visit in sharpening our understanding of, and ultimately defining, the specific elements of "head" and "book", including their generic descriptions.

T. Powers

TABLE 1

PHYSICAL & MENTAL CHARACTERISTICS IN MEETING JOB REQUIREMENTS*
(number selecting each characteristic)

	RATINGS					
Characteristic	BT	MM	EN	EM	IC	Total
1	6	5	2	3	5	21
2	5	5	2	3	3	18
3	5	5	2	3	3	18
4	2	0	1	2	2	7
5	5	3	1	5	4	18
6	1	1	0	3	1	6
7	2	1	1	2	2	8
8	2	5	1	2	2	12
9	2	1	0	1	0	4
10	5	3	1	3	2	14
11	1	1	0	0	0	2
12	1	1	0	0	0	2
13	1	1	0	2	0	4
14	1	1	0	0	0	2
15	5	4	2	5	5	21
16	3	2	1	4	2	12
17	1	1	0	4	4	10
18	4	6	0	0	3	13
19	3	3	0	1	2	9
20	6	4	2	1	3	16
21	5	5	2	3	4	19
22	1	2	0	2	3	8
23	1	1	1	0	0	3
24	4	3	0	4	0	11
25	2	3	0	1	1	7
26	3	5	0	4	3	15
27	3	3	1	1	1	9
28	2	2	0	0	1	5
29	2	2	0	0	0	4
30	5	6	1	3	3	18
31	6	3	1	5	3	18
32	5	6	1	4	3	19
33	6	4	1	2	3	16
34	1	1	0	1	0	3
35	0	1	0	0	0	1
36	6	3	1	1	3	14
37	6	3	2	3	4	18
38	5	5	1	3	3	17
39	5	6	1	5	3	20

N	
BT	= 6
MM	= 7
EN	= 2
EM	= 5
IC	= 5
TOTAL	=25

* Characteristics were taken from the NOTAP Task Inventory for these ratings.

NOTE: Underscored numbers indicate that the count was above the median for that characteristic for the rating (or "total") indicated.

TABLE 2

PHYSICAL & MENTAL CHARACTERISTICS IN MEETING JOB REQUIREMENTS*
(highest selected characteristics and degrees of importance)

Characteristic	RATINGS BT	MM	EN	IC	EM	Total
1	X	X	X		X	X
2	X	X	X			
3			X			
4						
5	X		X			X
6						
7						
8						
9						
10	X					
11						
12						
13						
14						
15	X		X	X	X	X
16				X		
17				X	X	
18		X				
19						
20	X	X	X		X	X
21	X	X	X	X	X	X
22					X	
23						
24	X				X	
25						
26		X		X	X	
27						
28						
29						
30	X	X		X	X	X
31	X			X	X	X
32	X	X		X	X	X
33	X				X	X
34						
35						
36	X				X	
37	X		X	X	X	X
38	X	X			X	X
39	X	X		X	X	X

N

BT = 6
MM = 7
EN = 2
EM = 5
IC = 5
TOTAL =25

*Characteristics were taken from the NOTAP Task Inventory for these ratings. (see Attachment 2)

NOTE: Only characteristics with an aggregate weighted score above the mean for one or more ratings are listed. A X indicates the rating and characteristic for which an above-the-mean score was received.

TABLE 3

TAEG PERFORMANCE TASKS*
(The Number Indicating Each PT is Necessary in the Job Task Described)

RATINGS

Performance Task	BT #	MM #	EN #	EM #	IC #	Total #
1	6	6	2	5	5	24
2	4	4	1	2	4	15
3	5	5	1	4	4	19
4	5	4	2	4	4	19
5	6	6	2	5	4	23
6	2	4	2	2	1	11
7	5	3	0	5	5	18
8	3	4	0	0	3	10
9	5	7	2	5	5	24
10	0	0	0	0	0	0
11	2	2	1	2	0	7

N

BT = 6
MM = 7
EN = 2
EM = 5
IC = 5
TOTAL =25

* The Performance Tasks are reported in: James A. Aagard & Richard Braby, Learning Guidelines and Algorithms for Types of Training Objectives TAEG Report No. 23, March 1976.

Attachment 1

Booklet No. _____

INSTRUCTIONS

In the space below briefly describe any job task in your rate which you would require technical data (the presence of a technical manual) to perform.

_____

_____

_____

_____

_____

_____

_____

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_____

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_____

_____

_____

Attachment 2

PHYSICAL AND MENTAL CHARACTERISTICS
USED IN MEETING JOB REQUIREMENTS

1. Finger, hand, wrist, and forearm strength
2. Upper arm strength
3. Back and shoulder strength
4. Leg, foot, and ankle strength
5. Foot-eye-hand coordination
6. Ability to perform rapid work for a series of short periods
7. Ability to perform rapid work for extended periods
8. Ability to perform heavy work for a series of short periods
9. Ability to perform heavy work for extended periods
10. Ability to stand for extended periods
11. Maximum height limitations
12. Minimum height limitations
13. Maximum weight limitations
14. Minimum weight limitations
15. Sharpness of vision
16. Sharpness of hearing
17. Ability to distinguish between different colors and shades (color perception)
18. Ability to estimate size
19. Ability to estimate speed
20. Ability to estimate quality
21. Ability to discriminate by touch ("feel" of objects)
22. Ability to discriminate between odors (sense of smell)

23. Ability to discriminate between salty, sour, sweet (sense of taste)

24. Ability to remember names, places, ideas

25. Ability to remember oral instructions

26. Ability to work with mathematical computations or formulas

27. Ability to plan projects or events

28. Ability to make oral presentations (such as lectures, briefings)

29. Ability to draft or write reports, correspondence

30. Ability to give attention to several items at the same time

31. Ability to concentrate amid distractions

32. Ability to work as a team member

33. Ability to perform detailed work over extended periods of time

34. Ability to work in high places

35. Ability to work in extremely cold temperatures

36. Ability to work in extremely hot temperatures

37. Ability to work under pressure and stress

38. Ability to work in confined areas

39. Ability to hear changes in equipment in a high noise level environment

Attachment 3

PERFORMANCE TASKS

TASK	EXAMPLE
1. RECALLING BODIES OF KNOWLEDGE	1. Recalling equipment nomenclature or functions. 2. Recalling system functions, such as complex relations between the system's input and output. 3. Recalling physical laws, such as Ohm's law. 4. Recalling specific radio frequencies and other discrete facts.
2. USING VERBAL INFORMATION	1. Based on academic knowledge, determine which equipment to use for a specific real world task. 2. Based on an academic knowledge of the system, compare alternative modes of operation of a piece of equipment and determine the appropriate mode for a specific real world situation. 3. Based on memorized knowledge of radio frequencies, choose the correct frequency in a specific real world situation.
3. RULE LEARNING AND USING	1. Applying the "rules of the road". 2. Solving mathematical equations (both choosing correct equipment and the mechanics of solving the equation. 3. Carrying out military protocol. 4. Selecting proper fire extinguisher for different type fires. 5. Using correct grammer in novel situation, covered by rules.

TASK	EXAMPLE
4. MAKING DECISIONS	1. Choosing frequencies to search in an ECM search plan. 2. Choosing torpedo settings during a torpedo attack. 3. Assigning weapons based on threat evaluation. 4. Choosing tactics in combat - wide range of options. 5. Choosing a diagnostic strategy in dealing with a malfunction in a complex piece of equipment. 6. Choosing to abort or commit oneself to land upon reaching the critical point in the glidepath.
5. DETECTING	1. Detecting sonar returns from a submarine target. 2. Visually detecting the periscope of a snorkeling submarine during daytime operations in a sea state of three. 3. Detecting, through a slight change in sound, a bearing starting to burn out in a power generator.
6. CLASSIFYING	1. Classifying a sonar target as "sub" or "non-sub". 2. Visually classifying a flying aircraft as "friend" or "enemy" or as an "F-4". 3. Determining that an identified noise is a wheel bearing failure, not a water pump failure by rating the quality of the noise - not by the problem solving approach.

TASK	EXAMPLE
7. IDENTIFYING SYMBOLS	1. Reading electronic symbols on a schematic diagram. 2. Identifying map symbols. 3. Reading and transcribing symbols on a tactical status board. 4. Identifying symbols on a weather map.
8. VOICE COMMUNICATING	1. Officer giving oral orders and receiving reports. 2. Sonar operator passing oral information over communication net. 3. Instructions by GCA operator to pilot in landing aircraft.
9. RECALLING PROCEDURES, POSITIONING MOVEMENT	1. Recalling equipment assembly and disassembly procedures. 2. Recalling the operation and check out procedures for a piece of equipment (cockpit check lists). 3. Following equipment turn-on procedures - emphasis on motor behavior.
10. GUIDING AND STEERING, CONTINUOUS MOVEMENT	1. Submarine bow and stern plane operators maintaining a constant course, or making changes in course or depth. 2. Tank driver following the road. 3. Sonar operator keeping the cursor on a sonar target. 4. Air-to-air gunner - target tracking.

TASK	EXAMPLE
	5. Aircraft piloting such as visually follo[illegible] a ground path. 6. Helmsman holding a course with gyro or magnetic compass.
11. PERFORMING GROSS MOTOR SKILLS	1. From a kneeling position, throw an M67 Fragmentation hand grenade 40 meters on target within effective casualty radius (ECR) using acceptable technique. 2. Wearing a utility jacket, utility trousers, combat boots and armed with M16 rifle, traverse 75 meters in deep water using correct form. 3. Demonstrate the proper technique for a parachute landing fall (PLF) in open terrain. 4. Demonstrate the proper technique of creeping at night across open terrain armed with a rifle. 5. Demonstrate the proper technique of chin-ups starting from "dead" hang, palms toward face position.

29 October 1976

From: T. E. Powers

To: R. A. Sulit

Subject: Trip Report to Service School Command, U. S. Naval Training Center, Great Lakes, Illinois, dated 6-8 October 1976.

1. Purpose

This was a follow-up of the 23-27 August 1976 visit to Service School Command, Great Lakes. Similar to the August visit, the purpose was to gather preliminary information about job tasks performed using technical data. More exactly, it was the intent of both visits to obtain information concerning:

a. the nature of job tasks which require the use of technical data to perform.

b. the kinds of mental and physical elements related to the performance of job tasks involving the use of technical data.

c. the kinds of mental and physical prerequisite skills required to perform job tasks using technical data.

2. Personnel Contacted

a. CDR R. M. Burman, X.O., SSC, GLAKES
b. LCDR E. F. Large, Director, Electronics School
c. LTJG W. M. Bromagin, Ass't Director, Electronics School
d. LCDR D. M. Longcore, Director, Firecontrol Technician School
e. LT L. R. Rupertus, Director, Gunnery School
f. LTJG J. W. McMullen, Ass't Director, Gunnery School
g. CWO3 K. L. Schroeder, Director, Operations Specialist School
h. GMCM J. W. Webb, Curriculum and Instructional Standards Officer
i. Forty-one (41) petty officers; eleven (11) GM's; ten (10) ET's; ten (10) FT's; and ten (10) OS's.

3. Description

Thirty-one petty officers (E5-E8) from the GM, FT, AND ET Schools completed questionnaires (see Attachments 1 and 2) related to

job task performances. The first (Attachment 1) was intended to obtain information about the physical/mental characteristics and their relative importance in meeting job requirements. Another reason for having administered the questionnaire was to determine whether there seemed to be any noticeable differencesin these characteristics for Engineering and Hull ratings (previously given the same questionnaire in August at Great Lakes -- i.e., to BT's, MM's, EN's, EM's, and IC's), as compared with Electronics and Ordnance ratings (i.e., the ET's, GM's, and FT's who completed the questionnaire in October).

The second questionnaire (see Attachment 2) contained a list of elements which seemed to be related to job task performance by Navy technicians. The list was compiled from interviews conducted with petty officers at SSC, GLAKES in August 1976. In the questionnaire, the respondents had to distinguish among the elements listed according to five categories: (1) this element ought to be contained in technical manuals (TM); (2) this element belongs in the technician's head (TH) -- that is he already knows that element and therefore does not require it in a technical manual; (3) not certain whether this element belongs in the technician's head or in a technical manual; (4) TM and TH -- that is, although this element is usually known by a technician, it still might be useful to include in a technical manual; and (5) this element is not essential to performing most job tasks. As with the first questionnaire, the respondents were asked to rate the importance of each element to job tasks performed by them.

In addition to the thirty-one (31) petty officers who completed the two questionnaires, ten operations specialists (OS's) were interviewed concerning the range of job tasks performed by OS personnel in the Navy. Since OS petty officers perform operator duties for the most part -- as compared with maintenance duties, it seemed important to determine whether there were any job task elements essential or exclusive to operators.

4. Results

a. Physical and Mental Characteristics in Meeting Job Requirements

There was far more similarity than dissimilarity across ratings with respect to the characteristics listed in Attachment 3). Although a detailed analysis of the data was completed, including comparisons with the BT's, MM's, EN's, EM's, and IC's of the August visit, the specifics of that analysis are purposely omitted from this report because those data were intended to provide information for a final questionnaire on job tasks to be given at a number of Navy sites rather than to provide conclusive findings regarding the physical and mental characteristics of the ratings themselves. It is sufficient to report here that the

elements of importance and commonality across the ratings, based on responses from the petty officers questioned, were:

- physical characteristics: finger, hand, wrist, and forearm strength; foot-eye-hand coordination; sharpness of hearing; sharpness of vision; and color perception.
- mental characteristics: ability to estimate quality; discriminate by touch; remember names, places, and ideas; remember oral instructions; give attention to several items at the same time; concentrate amid distractions; work as a team member; perform detailed work over extended periods of time; work under pressure and stress; work in confined places; and hear changes in equipment in a high noise environment.

b. Elements Related to Job Task Performance

Attachment 2 was not used to obtain definitive data concerning the elements of job tasks, but rather to determine if such a list of elements was understandable and whether it seemed to be representative of the major elements which make up Navy job tasks. Perhaps the most important question explored by this questionnaire was whether personnel could in effect define the conditions for performing job tasks -- i.e., by differentiating among elements which should be embodied in technical data presentation and elements which are normally known (in a technician's head, so to speak) at the time of job task performance.

An analysis of the responses to the questionnaire suggested that the list of elements is representative of the major elements in job task performance by a Navy technician. As Attachment 3 shows, only seven elements were identified by anyone as unnecessary to job task performance -- six of these having been identified by only one respondent; and by only three, for the seventh one. Moreover, only three respondents offered any kinds of additions to the list.

The fact that very few respondents indicated uncertainty ("?" column) about the elements belonging in a technician's head, a technical manual, or in both, at least suggested that Navy technicians would have little difficulty in responding to similar questions in the final questionnaire having to do with the conditions of job task performance. Also, the fact that at least a majority of the petty officers were able to classify 39 of the 43 elements as belonging to either the "head" or the "TM" indicated that head/TM differentiations can be made by technicians.

Although Attachment 3 is not intended for making comparisons by rating groups with respect to the responses to the elements, one cannot help but notice the similar patterns of responses for all three ratings with respect to a number of the elements (e.g., 1, 2, 5, 7, 11, 12, 13, 14, etc.). These patterns at least suggested that any subsequent search for commonalities in job task performance across ratings will yield positive results.

A group discussion with the personnel in each rating followed the completion of the questionnaire. This procedure proved to be extremely useful in flushing out and refining vague elements, procedures, and directions. The meeting with the OS personnel was equally useful in determining the degree to which operators would be able to respond to the elements in Attachment 3.

Attachment 1

PHYSICAL AND MENTAL CHARACTERISTICS USED IN MEETING JOB REQUIREMENTS

1. Finger, hand, wrist, and forearm strength
2. Upper arm strength
3. Back and shoulder strength
4. Leg, foot, and ankle strength
5. Foot-eye-hand coordination
6. Ability to perform rapid work for a series of short periods
7. Ability to perform rapid work for extended periods
8. Ability to perform heavy work for a series of short periods
9. Ability to perform heavy work for extended periods
10. Ability to stand for extended periods
11. Maximum height limitations
12. Minimum height limitations
13. Maximum weight limitations
14. Minimum weight limitations
15. Sharpness of vision
16. Sharpness of hearing
17. Ability to distinguish between different colors and shades (color perception)
18. Ability to estimate size
19. Ability to estimate speed
20. Ability to estimate quality
21. Ability to discriminate by touch ("feel" of objects)
22. Ability to discriminate between odors (sense of smell)

23. Ability to discriminate between salty, sour, sweet (sense of taste)

24. Ability to remember names, places, ideas

25. Ability to remember oral instructions

26. Ability to work with mathematical computations or formulas

27. Ability to plan projects or events

28. Ability to make oral presentations (such as lectures, briefings)

29. Ability to draft or write reports, correspondence

30. Ability to give attention to several items at the same time

31. Ability to concentrate amid distractions

32. Ability to work as a team member

33. Ability to perform detailed work over extended periods of time

34. Ability to work in high places

35. Ability to work in extremely cold temperatures

36. Ability to work in extremely hot temperatures

37. Ability to work under pressure and stress

38. Ability to work in confined areas

39. Ability to hear changes in equipment in a high noise level environment

GREAT LAKES SURVEY FORM
OCTOBER, 1976

Listed inside are examples of things which might be important to a Navy technician in performing maintenance tasks related to equipments. Some of these items might be things he should know (i.e., have in his head), while others might be things which should be contained in a technical manual (i.e., NOT in his head). Therefore, please identify each item by circling the appropriate symbol as follows:

TM: belongs in a technical manual

H: belongs in a technician's head

?: undecided as to where it belongs: technical manual or technician's head

B: BOTH: belongs equally in Technical Manual and in the technician's head

U: unnecessary: Item is not essential to performing a maintenance task

Then, for each item select the appropriate letter (a, b, c, d, or e) from the scale below to indicate the importance of that item for performing most maintenance tasks performed by you. Write the letter in front of each item.

a. Very Important

b. Important

c. Average Importance

d. Slightly Important

e. Almost UNimportant

NOTE: At the end of this form, you will find two opportunities for additional comments:

1. "Other" items you wish to add to the list. Please indicate where these "other" items belong (TM, H, ?, or B), and the degree of importance (a, b, c, d, e) of each

2. "Remarks": any kind of explanatory comments you wish to make regarding any of the items or the way you rated them.

TM H ? B U 1. Procedures for disassembling a unit in a system.

TM H ? B U 2. Procedures for assembling a unit in a system.

TM H ? B U 3. The general theory related to the unit or system being maintained.

TM H ? B U 4. The principles of operation related to the unit or system being maintained.

TM H ? B U 5. List of the names of the parts or components of a unit.

TM H ? B U 6. The meaning of symbols in schematics, etc.

TM H ? B U 7. Pictures of parts or components.

TM H ? B U 8. Explanations of how components and units function.

TM H ? B U 9. The functions of a unit and its components.

TM H ? B U 10. The relationship of a unit and its components to an entire system.

TM H ? B U 11. Specification information: for example, calibrations, settings, clearances, voltage readings, etc.

TM H ? B U 12. Names of basic tools.

TM H ? B U 13. Functions of basic tools.

TM H ? B U 14. How to use basic tools.

TM H ? B U 15. Safety information: precautions, trips, etc.

TM H ? B U 16. Names of terms, parts, etc. and their meaning.

TM H ? B U 17. The location of parts and components in a unit.

TM H ? B U 18. Troubleshooting procedures and steps.

TM H ? B U 19. Troubleshooting options (i.e., symptoms, causes, remedies).

TM H ? B U 20. Procedures for getting a needed part.

TM H ? B U 21. Procedures for beginning disassembly work.

TM H ? B U 22. Test procedures.

TM H ? B U 23. Maintenance procedures.

TM H ? B U 24. Repair procedures.

TM H ? B U 25. Ability to differentiate (visually) between components and parts.

TM H ? B U 26. Names of special tools.

TM H ? B U 27. Descriptions of special tools.

TM H ? B U 28. How to use special tools.

TM H ? B U 29. Procedures for using a technical manual.

TM H ? B U 30. "Rule of thumb" knowledge.

TM H ? B U 31. Schematics, drawings, prints, diagrams, etc.

TM H ? B U 32. Spare parts lists and Navy stock numbers.

TM H ? B U 33. How to read and comprehend schematics, prints, etc.

TM H ? B U 34. How to read and comprehend printed information.

TM H ? B U 35. Definitions of terms.

TM H ? B U 36. Test procedures.

TM H ? B U 37. Legends for symbols on schematics, etc.

TM H ? B U 38. General safety rules.

TM H ? B U 39. How to use basic test equipment.

TM H ? B U 40. Formulas which might be involved.

TM H ? B U 41. How to read and interpret data.

TM H ? B U 42. Basic troubleshooting rules.

TM H ? B U 43. How to recognize common symptoms of trouble.

TM H ? B U 44. _____

_____

TM H ? B U 45. _____

_____

TM H ? B U 46. _____

_____

TM H ? B U 47. _____

_____

TM H ? B U 48. _____

_____

TM H ? B U 49. _____

_____

TM H ? B U 50. _____

_____

REMARKS: _____

_____

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_____

_____

_____

ELEMENTS IN PERFORMING JOB TASKS

Number Selecting TM, H, ?, B, or U

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Gunners Mates																								
TM	9	9	3	2	6	1	10	8	5	2	10				1	5	5	6	4		6	8	4	6
H			6	6	1	4		1	1	3		10	10	11	9	3	4	1	4	6	2	1	1	1
?																				1			1	
B	2	2	2	3		6	1	2	5	6	1	1	1		1	3	2	4	3	4	3	2	5	4
U																								
Firecontrol Technicians																								
TM	6	6	2	1	4	4	8	1	2	1	8	1					3				3	4	5	3
H			4	1	1			4	1	1		7	8	8	2	1			2	2	1			
?										1	2					1								
B	4	4	4	8	5	6	1	5	7	7		2	2	2	8	7	7	10	8	7	5	6	5	7
U																				1				
Electronic Technicians																								
TM	8	8	3	7	9		8	6	7	6	10				1	1	10	3	4	2	7	7	7	3
H			2	1	1	8		1	2	3		9	10	10	3	4		2	3	6	1			2
?																								
B	2	2	5	2		2	1	3	1	1					6	5		5	3		1	3	3	5
U							1					1								2				
TOTAL																								
TM	23	23	8	10	10	5	26	15	14	9	28	1		29	2	6	18	9	8	2	16	19	16	12
H			12	8	3	12		6	4	7		26	28		14	8	4	3	9	14	4	1	1	2
?										1						1				1			1	1
B	8	8	11	13	9	14	3	10	13	14	3	3	3	2	15	15	9	19	14		9	11	13	16
U							1					1												

ELEMENTS IN PERFORMING JOB TASKS (cont'd)
Number Selecting TM, H, ?, B, or U

	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
Gunners Mates																			
TM		3	6	4	3		8	11		1	5	9	6	2	2	5	2		
H	9	4	2	2	5	9	2		8	10	4			4	5	1	7	7	6
?	1		1													1			
B	1	4	2	5	3	1	1		3		2	2	5	5	4	3	2	4	5
U						1													
Firecontrol Technicians																			
TM		2	4	4	1		10	10			1	5	6			6	1		
H	3	1			3	6			5	9			1	1	4			5	4
?	1					1				1									
B	6	7	6	6	6	3			5		9	5	3	9	6	4	9	5	6
U																			
Electronic Technicians																			
TM		7	8	8			10	9			6	7	3			3			
H	8	2	1	1	7	10			9	10			4	7	10	3	9	10	9
?			1	1					1		2						1		
B	2				3						2	3	3	3		4			1
U		1						1											
TOTAL																			
TM		12	18	16	4		28			1	12	21	15	2	2	14	3		
H	20	7	3	3	15	25	2		22	29	4		5	12	19	4	16	22	19
?	2		2	1		1	1			1	2					1	1		
B	9	11	8	11	12	4			9		13	10	11	17	10	11	11	9	12
U		1				1										1			

Booklet Number _____ 11-76

Rate _____ Primary NEC _____

Secondary NEC _____

Navy Category (circle one): USN USNR USNR (inactive)
SURTAR AIRTAR

Age _____ Sex _____ GCT (if known) _____

Number of months in this command _____

Present job title _____

When performing jobs as a Navy technician (working on equipment/ hardware), are you (check one):

_____ Maintenance Technician

_____ Operator

Highest level of Civilian education completed (check one):

_____ Less than 8th grade

_____ Less than 12th grade

_____ High School graduate

_____ Some college, but less than 4 years

_____ Graduate of 4 Yr. College Program

_____ Some graduate work, but no graduate degree

_____ Graduate degree (for example, M.A., Ph.D., etc.)

Military Schools Attended:

School (Course) Title	Approximate Length of School (Course)	Approximate Year

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JOB TASK CATEGORIES

A. ASSEMBLE/DISASSEMBLE (component parts, components, and/or equipment/ hardware)

often occasionally seldom never

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18

19 20 21 22 23 24 25 26 27 28 29 30 31 32

B. TEST/INSPECT (component parts, components, and/or equipment/ hardware)

often occasionally seldom never

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18

19 20 21 22 23 24 25 26 27 28 29 30 31 32

C. TROUBLESHOOT/REPAIR (component parts, components, and/or equipment/ hardware)

often occasionally seldom never

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18

19 20 21 22 23 24 25 26 27 28 29 30 31 32

D. CLEAN/LUBRICATE (component parts, components, and/or equipment/ hardware)

often occasionally seldom never

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18

19 20 21 22 23 24 25 26 27 28 29 30 31 32

E. FLUSH/PURGE (component parts, components, and/or equipment/hardware)

often occasionally seldom never

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18

19 20 21 22 23 24 25 26 27 28 29 30 31 32

F. ADJUST/ALIGN (component parts, components, and/or equipment/hardware)

often occasionally seldom never

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18

19 20 21 22 23 24 25 26 27 28 29 30 31 32

G. REMOVE/REPLACE (component parts, components, and/or equipment/ hardware)

often occasionally seldom never

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18

19 20 21 22 23 24 25 26 27 28 29 30 31 32

H. RIG/UNRIG (component parts, components, and/or equipment/hardware)

often occasionally seldom never

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18

19 20 21 22 23 24 25 26 27 28 29 30 31 32

I. OPERATE/SECURE (component parts, components, and/or equipment/ hardware)

often occasionally seldom never

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18

19 20 21 22 23 24 25 26 27 28 29 30 31 32

J. PACKAGE/UNPACKAGE (component parts, components, and/or equipment/ hardware)

often occasionally seldom never

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18

19 20 21 22 23 24 25 26 27 28 29 30 31 32

K. OTHER (specify): _____

often occasionally seldom

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18

19 20 21 22 23 24 25 26 27 28 29 30 31 32

KNOWLEDGE/SKILL ELEMENTS IN PERFORMING JOB TASKS

General Knowledge

1. Theory and/or principles of operation of equipment/hardware and/or its components.
2. How components and component parts relate to entire equipment/hardware system.
3. How components and component parts function.
4. Various formulas, rules, principles, etc.

Knowledge of Nomenclature

5. Names of components and/or component parts in equipment/hardware.
6. Names of basic hand tools.
7. Names of special hand tools.
8. Names of basic testing equipment.
9. Names of special testing equipment.

Skills

10. How to use basic hand tools.
11. How to use special hand tools.
12. How to use basic testing equipment.
13. How to use special testing equipment.
14. How to read visual aids (e.g., diagrams, schematics, etc.)
15. How to read symbols.
16. How to read text materials.

Procedures

17. Assembly/disassembly procedures.
18. Basic troubleshooting procedures.

19. Special troubleshooting procedures (e.g., isolating trouble through a fault logic chart).

20. Basic test equipment procedures.

21. Special test equipment procedures.

22. Basic maintenance procedures.

23. Special maintenance procedures.

Safety

24. Basic safety rules.

25. Special safety precautions, warnings, trips, etc.

Special Information and Skills

26. "Visual Information: e.g., flows, patterns, interconnection of component parts and components, etc. (usually shown on a schematic, diagram, blueprint, sketch, etc.)

27. Specific calibrations, settings, clearance, voltages, etc. for tools, testing equipment, and/or component parts.

28. The meaning of symbols in schematics, drawings, diagrams, prints, etc.

29. Special terminology and vocabulary associated with your rating (technical jargon, acronyms, etc.)

30. Research and reference skills.

31. Ability to differentiate between component parts and components.

32. Skills in how to operate equipment/hardware.

OTHER

33. (Specify) _____

34. (Specify) _____

35. (Specify) _____

Navy Ratings and Occupation Groups

Rating Abbrev.	Rating Description
Group I - Deck	
BM	Boatswain's Mate
MA	Master-At-Arms
QM	Quartermaster
SM	Signalman
OS	Operations Specialist
EW	Electronic Warfare Technician
ST	Sonar Technician
STG	Sonar Technician (Surface)
STS	Sonar Technician (Submarine)
OT	Oceanographic Technician
Group II - Ordnance	
TM	Torpedoman's Mate
GM	Gunner's Mate
GMM	Gunner's Mate Missiles
GMT	Gunner's Mate Technician
GMG	Gunner's Mate Guns
FT	Fire Control Technician
FTG	Fire Control Technician Guns
FTM	Fire Control Technician Surface Missile
FTB	Fire Control Technician Ballistic Missile
MT	Guided Missileman
MN	Mineman
Group III - Electronics	
ET	Electronic Technician
ETN	Electronic Technician Communications
ETR	Electronic Technician Radar
DS	Data Systems Technician
Group IV - Precision Equipment	
PI	Precision Instrumentman
IM	Instrumentman
OM	Opticalman

Rating Abbrev.	Rating Description
Group V - Administrative and Clerical	
NC	Navy Counselor
RM	Radioman
CTT	Communications Technician T
CTA	Communications Technician A
CTM	Communications Technician M
CTO	Communications Technician O
CTR	Communications Technician R
CTI	Communications Technician I
YN	Yeoman
LN	Legalman
PN	Personnelman
DP	Data Processing Technician
SK	Storekeeper
DK	Disbursing Clerk
CS	Commissaryman
SD	Steward
SH	Ship's Serviceman
JO	Journalist
PC	Postal Clerk
Group VI - Miscellaneous	
LI	Lithographer
DM	Illustrator Draftsman
MU	Musician
Group VII - Engineering and Hull	
MM	Machinist's Mate
EN	Engineman
MR	Machinery Repairman
BT	Boiler Technician
BR	Boilermaker
EM	Electrician's Mate
IC	IC Electrician
HT	Hull Technician
PM	Patternmaker
ML	Moler
GS	Gas Turbine System Technician
Group VIII - Construction	
CU	Construction Man
EA	Engineering Aide
CE	Construction Electrician
EQ	Equipmentman
EO	Equipment Operator

Rating Abbrev.	Rating Description
Group VIII - Construction (cont'd)	
CM	Construction Mechanic
BU	Builder
SW	Steelworker
UT	Utilities Man
Group IX - Aviation	
AF	Aircraft Maintenance Technician
AV	Avionics Technician
AD	Aviation Machinist's Mate
ADR	Aviation Machinist's Mate Reciprocating Engines
ADJ	Aviation Machinist's Mate Jet Engines
AT	Aviation Electronics Technician
AX	Aviation Antisubmarine Warfare Technician
AW	Aviation Antisubmarine Warfare Operator
AO	Aviation Ordnanceman
AQ	Aviation Fire Control Technician
AC	Air Controlman
AB	Aviation Boatswain's Mate
ABE	Aviation Boatswain's Mate Launch and Recovery
ABF	Aviation Boatswain's Mate Fuel Handling
ABH	Aviation Boatswain's Mate Aircraft Handling
AE	Aviation Electrician's Mate
AM	Aviation Structual Mechanic
AMS	Aviation Structual Mechanic Structures
AMH	Aviation Structual Mechanic Hydraulics
AME	Aviation Structual Mechanic Safety Equipment
PR	Aircrew Survival Equipmentman
AG	Aerographer's Mate
TD	Training Deviceman
AK	Aviation Storekeeper
AZ	Aviation Maintenance Administrationman
AS	Aviation Support Equipment Technician
ASE	Aviation Support Equipment Technician Electrical
ASH	Aviation Support Equipment Technician Hydraulic/Structures
ASM	Aviation Support Equipment Technician Mechanical
PH	Photographer's Mate
PT	Photographic Intelligenceman

Rating Abbrev.	Rating Description
Group X - Medical	
HM	Hospital Corpsman
Group XI - Dental	
DT	Dental Technician

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