BSD-TDR-63-125

REPORT NO.
TDR-169 (3741-08) TN-1

The Comparative Validity of Manpower Prediction Techniques

24 JUNE 1963

Prepared by GROUND SYSTEMS DEPARTMENT
Systems Research and Planning Division

Prepared for COMMANDER HEADQUARTERS, BALLISTIC SYSTEMS DIVISION
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE
Norton Air Force Base, California

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Prepared by

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2400 East El Segundo Boulevard
El Segundo, California

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THE COMPARATIVE VALIDITY OF MANPOWER PREDICTION TECHNIQUES

24 June 1963

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FOREWORD

This study was conducted under the cognizance of the Ground Systems Department of the Systems Research and Planning Division of Aerospace Corporation. R. W. Cunningham and E. H. Edwards of this department defined and coordinated the general tasks required in support of a personnel subsystems applied research activity. This activity was initiated by the Laboratories Division in response to DCAS-TDR-62-80 "Research Proposals for Personnel Subsystem State-of-the-Art Advancement in Ballistic and Space Systems Development" and an Air Force Work Request BSO-62-0001, dated 30 July 1962.

The study was accomplished and the report prepared by J. C. Powell of the Cost Department, System Analysis and Evaluation Subdivision, under MJO 3741-08.

This study was under the cognizance of the Perscnnel Subsystem Branch, BSOSP, at Norton AFB under Lt Col H. Clymer and Capt M. Majesty, Project Officer.

Two other reports, Comparison of Training Equipment Requirements for Military Training Programs, TDR-169(3741-08)TN-3, and The Determination of Technical Manual Utilization and Adequacy, TDR-169(3741-08)TN-2, were produced concurrently. Reference is made here to afford a cross-reference for interested individuals working in the applicable personnel subsystems area.

ABSTRACT

This report presents the results of a research effort within the personnel subsystems area conducted to ascertain the validity of various manpower prediction techniques. The report consists of a literature survey including bibliography listings and annotations; a state-of-the-art summary based on the literature survey; and plans and recommendations for future research in the specific area of manpower prediction.

CONTENTS

I. SUMMARY

Manpower requirements estimating is performed on every weapon system that is developed. However, the methods or techniques used to prepare these estimates are not specifically known in every detail, or reported as a matter of record, especially for a weapon system in the very early conceptual or advanced planning stage of development.

This document presents a four-part study plan designed to ascertain the existence and implementation of the detailed techniques used to predict or estimate manpower requirements. The plan consists of a literature survey, a field survey, the collation and analysis of data obtained and the publication of a final report. The scope of the investigation will include the four stages of a weapon system development. These four stages are the advanced planning stage, research and development stage, prototype manufacture and test stage, and the operating stage. The study plan is also designed to acquire sufficient information to allow recommendations for new techniques, changes in existing techniques and additional research in certain related areas.

The initial effort under this study plan, the literature search and survey, has been conducted by Aerospace Corporation. Documents showing new techniques, methods and procedures, other material pertaining to the subject, and existing Air Force publications are discussed with annotations provided for the most important items.

The literature survey showed that while there are fairly thorough procedures existing for describing positions and tasks, modifications are used extensively and no systematic attempts have been made to evaluate the strong and weak points contributing to their ultimate validity. A similar condition also exists with respect to the procedures for combining tasks into positions. It is also concluded that the determination of skill level requirements has received little methodological attention; comprehensive evaluation of results is lacking; however, more emphasis has been given to the rating of skill levels. Quantitatively manpower estimates have been affected, since apparently the use of automated equipment has not produced the saving in manpower as expected. The accuracy of manpower estimates is questioned, in the light of certain items obtained from QPRI sheets, and the research recommended

for this area could be expected to not only increase accuracy but also result in cost savings.

Recommendations include the implementation of the study plan presented in this report, with emphasis on the field survey and the subsequent continuation of the literature survey. It is also recommended that two separate studies be initiated to determine if certain restrictions can be removed from MIL Specification QPRI 26239A and AFBM Exhibit 58-18C.

II. INTRODUCTION

The need for, and value of, timely and accurate estimates of manpower requirements is self-evident in view of the long lead times necessary, and the large number of personnel and skills required for an Air Force Weapon System. The procedures, techniques or equations, by which estimates are established, frequently are not explicitly stated, especially when the estimates are made prior to the availability of complete personnel/equipment data (PED).

When explicit information explaining the development of each technique used to make estimates is not provided, the validity of the techniques cannot be adequately evaluated. One technique cannot be compared with different techniques to evaluate the one against the other. Therefore, it is necessary to proceed with the field survey to the sources of the estimates to determine at first hand the basis upon which they are made.

What techniques are now, or have been used in the recent past to develop manpower estimates? At the conceptual stage? At the feasibility stage? At the research and development stage but prior to firm design of equipments? What techniques are used to develop an estimate for Air Training Command (ATC) personnel requirements? Air Force Logistic Command (AFLC) requirements? Using command operational requirements?

A systematic compilation of the various procedures, techniques and methods used to prepare these manpower predictions should be accomplished in order to conduct a detailed analysis and subsequent appraisal of techniques. The comparative evaluation of the techniques to determine predictive accuracy could then identify those which lead to more accurate results and those which provide least accurate predictions.

III. DISCUSSION

A. General

The proposed study plan that is presented in Paragraph B of this discussion was prepared by Aerospace Corporation to define the areas wherein research was required in order to establish the comparative validity of manpower prediction techniques.

The initial effort under the plan, a search and survey of literature on the subject, disclosed that a comprehensive survey had been conducted in 1960 by the American Institute for Research under a USAF contract and was published as a WADD Technical Report (Reference 30). This report was a thorough professional presentation and was used as the starting point for the literature survey conducted by Aerospace Corporation.

The second phase of the study plan, which is called the "Data Collection" effort, is to be conducted at the source points of manpower estimating which are the government contractors plants and military establishments. This phase requires extensive field planning and is where the actual techniques are used. Academic theory as to how the art may be practiced has been set forth in some publications but the technique actually practiced can only be obtained at the source(s) where used. The field survey is therefore the primary phase of the tasks outlined in the study plan. The USAF command areas and the military contractors, suggested as contact points in the field planning, are listed in the study plan. The list is preliminary and should be modified and expanded as required to accomplish the desired results.

The field survey, which will entail personal contacts, will most probably have an influence on the planning, as set forth in the study plan, and may also modify the recommendations and conclusions presented in Section IV of this report.

B. Proposed Study Plan

The four-part study plan should be conducted within the technical areas previously described and the plans for implementation are described in the following paragraphs.

The weapons systems that should be used as a basis for the proposed study should be under direct control of BSD. They should be of such design and age that the estimating data obtained could be applicable to future systems; however, the existence of valid historical data is highly important. It is felt that the Thor, Atlas, Titan, and Minuteman systems would be adequate for the purposes of the study.

1. Literature Survey

a. Search the literature pertaining to the problem under study. This task has been accomplished for purposes of this study and is discussed in Paragraph C of this section.

b. Prepare an annotated bibliography for all documents with appropriate comments as to its relationship to the problem and its value. This task has also been accomplished consistent with the literature survey mentioned in (a) above.

2. Data Collection

a. Techniques used to Predict Manpower Requirements

These data will be collected by a field survey using prepared questionnaires to orient the interviewee to the problem. The contacts will be contractor representatives of the organizations shown under Paragraph d, with USAF Program and Project Offices, and the USAF military manpower planning personnel. The primary emphasis will be directed toward the technique, method or procedure that was actually used to prepare a bona fide estimate for one or more of the particular weapon systems.

b. Original Manpower Estimates

In part, this is a derivative output of the field survey. Program plans, development plans and/or operation plans may be requested from USAF technical libraries, if necessary or expeditious. An attempt will be made to build up the "original" estimate from the segments which were supplied by each of the cognizant Weapon System Program Office(s), and the higher AF echelons, for each of the weapon systems considered.

c. Actual Manpower Requirements

The prime purpose of the field study is to acquire this information. Unit manning documents will be used as the basis for this determination, plus or minus any in-the-field deviations. Contractor personnel performing tasks that are normally military tasks will be included in the military sector. An attempt will be made to determine the effect of training lead time on manpower requirements.

d. Field Survey Planning

Responsibility for manpower estimating is vested in military services and by contractual obligation in the military contractor. The lack of published literature or reports regarding the specific techniques used to obtain the estimates necessitates a field survey in both areas. For this study, the following specific USAF command areas and military contractors are suggested as primary contact points for collecting of information regarding specific techniques and methodology used in predicting personnel requirements.

Military:

Manpower planning personnel at USAF commands:

AFSC Ballistic Systems Division, Norton AFB, San Bernardino, California

Strategic Air Command Headquarters, Offutt AFB, Omaha, Nebraska

Air Training Command Headquarters, Randolph AFB, San Antonio, Texas

Air Logistics Command Headquarters, Wright-Patterson AFB, Dayton, Ohio

USAF Contractors:

Space Technology Laboratories
North American Aviation, Inc., Autonetics Division
AVCO, Research and Development Division
American Bosch Arma
Burroughs Corporation
Sylvania Corporation
Convair Astronautics
Aerojet-General Corporation
Boeing Company, Seattle
Martin-Denver
Bell Telephone Laboratories

AC Spark Plug Division of General Motors
General Electric Company
Paul Hardeman Company
Douglas Aircraft Company
Radio Corporation of America
Rand Corporation

Data Collection Forms:

The attempt to collect information, with regard to manpower prediction techniques, can be accomplished by the use of a prepared form or by the interview method or by a combination of both. The attached sample questionnaire is a preliminary effort designed to be used as an interview guide.

3. Evaluation of Techniques and Results

The evaluation of techniques and results should be as objective as is possible. However, the data available with regard to techniques and the basic assumptional data may not be sufficient for objective testing. The basic characteristics of a preferred technique should be based on past history and sound empirical knowledge, provision for all future perturbations, and predictions with time-phased accuracy.

The testing technique would provide for test of quantitative accuracy in total and/or by segments such as commands, functional areas, units, skill levels; all depending on the scope and quality of the data collected (see Table I).

If possible, suitable statistical tests would be applied to evaluate the accuracy of the various testing uses. Other tests would reveal the technique appropriate in the light of available information during each phase.

4. Publication of Findings

Publication of findings should be set forth in a report format that would best be determined at a later phase in the study, and consistent with results thereof.

C. Current Study Status

In accordance with the proposed study plan, a literature search was conducted with the assistance of the Aerospace Technical Library and the

Table 1. Manpower Prediction Summary.

System	Technique	Direct Operation	Indirect Operation	Direct Support	Indirect Support	Augmentation	Other	Total
A (e.g., Titan I)	x (e.g., Rand							
	y							
	z							
	Actual*							
B	x							
	y							
	z							
	Actual*							
C	x							
	y							
	z							
	Actual*							

*Based upon unit manning documents or field survey.

PRO FORMA INTERVIEW GUIDE

Name of Organization:

Address:

Department:

Individual:

Title of Individual:

1. Do you prepare manpower predictions for military organizations?
2. For what purpose? i.e., proposals, existing contract requirements, etc.
3. Under what contract?
4. In general, how do you go about the preparation of the estimate?
5. Do you have a written set of procedures or manuals? List.
6. Is this a full time assignment or is it just one of your functions?
7. Do you consider all military manpower or do you estimate only the "direct" personnel?
8. Do you have a definition of "direct" as distinguished from indirect?
9. Do you prepare task analyses?
10. Do you use any standard factors?
11. Specifically, what technique or techniques do you use when predicting manpower requirements?
12. What are the specific weapon systems for which you have used these techniques?
13. Do you have a copy of AFM 26-1, "Policy and Criteria Manual"?
14. How is this used?
15. Do you have a copy of USAF Planning Factors, AFM 172-3?
16. How is this used?
17. What other weapon systems have you prepared estimates for?
18. What are these estimates in detail or how can we obtain copies?
19. What other type of manpower estimating do you do; i.e., do you plan future requirements for your own organization?
20. What are your opinions as to present procedures and techniques used? Do we use too much effort in certain areas and too little in others?
21. Are the techniques used valid if we wish to arrive at a realistic estimate?

Armed Services Technical Information Agency. Principal sources of documents were: Wright Air Development Division, Air Research and Development Command; Rand Corporation; and the American Institute of Research. Most of the published literature available related to USAF weapon systems and publication was directly or indirectly sponsored by the Air Force.

Special efforts were made to search out reports which had not received wide distribution and to obtain unpublished literature on the subject. No documents were located which dealt directly with evaluation of techniques for prediction of manpower requirements or with the "Comparative Validity of Manpower Requirements Prediction Techniques" which is the task outlined for this study.

The lack of published literature in the area of estimating manpower requirements was clearly brought out in WADD Technical Report 60-493. This report, "A Survey of the Literature on Prediction of Air Force Personnel Requirements," by Folley, Fairman and Jones of American Institute of Research, published in July 1960, was the result of an exhaustive literature search. The authors stated "although this activity (estimating manpower requirements) is performed on every weapon system that is developed, only one report was found that deals specifically with a method for making these estimates".

Some progress has been made since the above was published. The number of documents received and reviewed under this present research program was 80, of which 30 were related to the study.

Paragraph D, immediately following, discusses the present state-of-the-art of manpower prediction based on the literature search and survey. The specific stages of weapon systems development, wherein predictions are made, are discussed and include:

Advanced planning stage
Research and development stage
Prototype, manufacture, and test stage
Operating stage

A complete bibliography listing all documents reviewed was made. Those items directly related to the study were annotated on separate sheets. These items are included in Section V.

D. State-of-the-Art According to Literature Survey

1. Advanced Planning Stage

a. General Discussion

Advanced planning for weapon systems is performed primarily by the military itself, directly or indirectly through their non-profit research organizations and prime contractors. The capability for predicting manpower requirements should exist within the advanced planning sections of these organizations in a broad general sense, and the skill-level of these personnel must be on a high order. However, the need for detailed predictions may not exist at this stage of a weapon system development. In a general sense, both economic resources and human factors are considered. The manpower requirements necessary for research, development, hardware, fabrication, and mission operation are also considered. As the mission operational personnel requirement is only a minor segment of the total manpower considerations at this stage of weapon system development, any attempt to estimate qualitative requirements in detail could be of questionable value. It is necessary to make good estimates of quantitative and also general qualitative personnel requirements.

System reliability and maintainability must be carefully considered at this point and care must be taken that manpower estimates for different systems use the same scope, i.e., flight, squadron, wing, support personnel, etc., to keep subsequent cost-effectiveness comparisons meaningful. Good techniques and planning personnel are required at this stage so as to improve decision making with respect to providing lead time sufficient to obtain the proper quantity of qualified personnel at the time required.

The manpower information generated at this stage of weapon systems development has implications for total national manpower resources, total military manpower and force structure, recruiting, training and educational processes. It also has a significant impact upon dollar costs and budgetary considerations, as reflected by the manpower predictions submitted in "Proposed System Package Plans" or other similar documents.

b. Applicable Documents

Recent published literature on manpower prediction techniques pertaining to this phase of a weapons system development are as follows:

Reference 1 - "Concepts for Estimating Air Force Manpower Requirements for Planning Purposes," by M. C. Heuston of Rand Corporation, 1 November 1960.

Reference 2 - "Manpower Planning Factors for Air Force Space Systems in the Conceptual Stages of Development," by M. C. Heuston of Rand Corporation, February 1962.

Reference 3 - "USAF Planning Factors" (AFM-172-3), issued by the Department of the Air Force, May 1962 and updated at intervals. (Title unclassified, contents classified. Suitable extracts however, can be made by authorized personnel having a "Need to Know".)

Reference 4 - "Policies, Procedures and Criteria" (AFM-26-1) issued by the Department of the Air Force, updated at intervals.

Reference 5 - "Procedure for Determining USAF Estimated Manpower Requirements", by J. C. Powell of Aerospace Corporation, May 1962 and updated at intervals.

Prior to the publication of References 1, 2, and 5, no literature on the subject was located either in the search conducted under this study or the exhaustive search conducted by the American Institute of Research under WADD Technical Report 60-493 in 1960. These documents are the first to make known a methodology or technique for estimating or predicting manpower requirements at the advanced planning stage.

References 1 and 2, abstracts of which appear in this report, are somewhat related as to content. They are of value as the technique used enables the analyst to arrive at a fair approximation of the quantitative number of personnel necessary for functional areas and a total manpower requirement.

The technique for predicting requirements in this advanced planning stage of weapons systems development as summarized from the two documents is:

(1) Create direct manpower requirements by using available published design criteria and discussions with advanced planners. Similar systems are considered as a guide. This results in a calculation of the number of "direct" manpower and a functional distribution such as pilots, missile launch operators, ground guidance crews or tracking crews.

(2) Create the direct support manpower requirements by utilization of all data used in (1) above. This is accomplished by factoring historical data. If no data exists, the analyst or planner must create a new basis. This factoring of data obtains a quantitative number of direct support manpower and a functional distribution such as missile assembly, launcher maintenance, fuel supply, etc.

(3) Indirect support manpower such as transportation, security, and food is calculated by use of factors. Factors are published by the Air Force and are based on combined experience and judgment. A good example would be AFM 172-3.

(4) Administrative support and major commands support are then calculated by use of factors.

(5) Command, i.e., wing, group, and headquarters are then calculated by use of historical data.

The addition of the numbers calculated in (1) through (5) will provide a quantitative total manpower estimate.

Reference 5, an abstract of which is part of this report, is more procedural in its makeup then References 1 and 2 although its methodology is similar. The procedure suggests the use of AFM-26-1 and AFM-172-3 as source documents for preparation of the estimate. Suggested sequential steps are:

(1) Estimate the manning requirement for the primary mission operation.

(2) Estimate the primary equipment necessary for the mission.

(3) Estimate the logistic and support manpower requirement for functions that are oriented to personnel.

(4) Estimate the logistic and support manpower requirement for functions that are oriented to equipment.

(5) Estimate the logistic and support manpower requirement for functions that are oriented to other factors such as dollars of sales, items purchased, rank of command, etc.

(6) Compute total manning requirement using formulae shown herein.

The procedure requires that worksheets be utilized and provides for a more detailed set of data if other than general estimates are necessary. Some charts which outline general functional areas, tables, and statistical information are included in this "use in-house only" procedural document.

References 3 and 4, abstracts of which are incorporated into this report, provide the planner and estimator with a general knowledge of Air Force policies, and planning information. A justifiable prediction of manpower requirements for Air Force systems cannot be made without the information contained in these Air Force manuals.

The five publications summarized above represent the only current literature available from the literature search and review and which are directly applicable to manpower estimating and prediction techniques in the advanced planning stage of weapons systems development.

2. Research and Development Stage

a. General Discussion

The necessity for a more detailed and searching analysis of manpower requirements is evident at this stage of a weapon system development because of the immediacy of fundamental decisions which may affect manpower recruitment and training or even total force structure. [illegible]nd development of weapon systems is primarily carried out by government contractors under a specific contract. The contract generally provides that manpower requirement data be furnished to the military service. The data are "called out" under military specifications, such as MIL Specification QPRI 26239A. Information submitted under this requirement is related only to the peculiar equipments being developed;

consequently, the itemized manpower quantity and qualifications requirements are very specific while any correlated system requirements remain general. Major contractors have "in-house" capability for producing these manpower requirements data. Subcontractors may have this capability or they may subcontract this effort to human factors specialists.

Present techniques in this stage of weapon systems development are primarily task analysis. The exact maintenance mode or operational concept is not fully developed, equipment data is not firm, the development process will continue throughout the acquisition phase, so system manpower requirements generated at this time are still tentative.

c. Under the concurrency concept, updated manpower predictions are essential during this phase. However, for the reasons listed above the estimates made at this time may not be advanced to the point where their use for recruiting or training is much more reliable than those obtained during the advanced planning stage. If improvements in advanced planning manpower estimations can be attained, it is possible that these could be used until Stage 5. This would represent a considerable savings during the critical research and development stages of any system.

b. Applicable Documents and Summary of Contents

Recent published literature that is related to manpower prediction techniques or methodology applicable in the research and development stage of weapons system development include the following:

Reference 6 - "Technical Data Requirements for Systems Engineering and Support," by T. F. Walton of Space Technology Laboratories, Inc., copyright in 1961 to the author. This massive, factual, well-written document is a text book that covers technical data requirements for research, development test, manufacturing, assembly and checkout, logistics, and operation. A complete chapter on [illegible] data [illegible] included in the book. A suggested method for preparing a basic set of cards (McBee Keysort or tabulating type) on which complete COFRI data can be recorded and later sorted for "cross slices" is excellent.

This text material applies to all phases of a weapons system development and presents in one volume a wealth of information that can only be helpful to the reader. If procedures outlined in the book relating to QQPRI are followed by contractor personnel, a good QQPRI report will result.

Reference 7 - "Handbook of Instructions for Aerospace Personnel Subsystems Designers" (AFSCM-80-3) published by the USAF and updated periodically. This manual contains guidance material for all individuals working in the area of human factors connected with Air Force weapons systems. The text is directed to the level of principles, philosophy and policy rather than to details.

Although the content of the manual relating to manpower estimates is excellent no techniques as such are published. The manual is necessary reading for any individual engaged in personnel subsystems work.

Reference 8 - "Automation and Personnel Requirements for Guided Missile Ground Support Function," by W. B. Knowles of Aerospace Medical Laboratory, May 1959. This study was conducted because personnel requirements were not declining with the use of automatic electronic ground equipment as had been expected. The results showed inadequate design objectives and requirements were the probable cause.

The reason for including this well-written document in the study report is that it provides additional evidence that predictions of manpower reduction because of automation are often overly optimistic. (See Reference 13 under Prototype Manufacture and Test for similar conclusions as applicable to automated checkout equipment.)

Reference 9 - "Collecting and Compiling Task Information for Newly Developed Guided Missiles," by Robert Glager, August 1953. This report presents a compilation of task information regarding a missile system and makes some recommendations regarding the collection of such information. It also contains good information as to the meaning of terms such as: task, summary, subtasks and behaviors, major decisions, etc. This U.S. Navy oriented publication, although 10 years old, is basic and is the best Navy document disclosed by our search.

Reference 10 - "Personnel Planning Information for the Air Force Satellite Control System," by M. V. Hill and K. J. Lindsay of Space Systems Division, Air Force Systems Command. This document shows some of the differences between forecasting personnel requirements for a research and development system and an operational system. It also presents a detailed comparison of the differences between Personnel Planning Information (AFSCSD Exhibit 61-94) and OQPRI (MIL D-26239A).

The publications as summarized above represent the current available literature (with the exception of Reference 9 which was published in 1963) directly or indirectly applicable to manpower estimating or prediction techniques at the research and development stage.

3. Prototype, Manufacture and Test Stage

a. General Discussion

The prediction of manpower requirements in this stage of weapon system development is far more detailed than in the preceding phases of development. The initial OQPRI has already been submitted and now updating, clarification, revision and detailing is a continuing effort until the system equipments are accepted. A system functional analysis is normally at hand, a system maintenance analysis has been produced, and detailed specific task analyses are prepared.

The primary military specification used is MIL D-26239A, USAF. Other specifications that are applicable are MIL W-9411, MIL D-9310, MIL D-9412, MIL H-25946, MIL F-25996 and MIL H-26207.

The basic technique used for predicting manpower requirements is task analysis. Generally, this technique is the calculation of human movements and mental processes required to make the system operate. Each necessary task is described, the equipments involved are identified, a name is given to the operation, a skill level is determined for the proper performance of the task, the time for performance of the task, and the frequency of task performance is estimated. The tasks are logically grouped together and those which satisfy a set of criteria, such as identical equipment and like complexity, are clustered into a position. Summations are then made of the time required for a task, the frequency of the task, plus additive factors such

as travel, personal time and the like, which permit a quantitative and qualitative resultant.

The resulting manpower requirements now are quite firm (see Figure 1). Much literature and many publications are available on this technique so the above is not meant to be a full and complete description of task analysis. It is submitted for purposes of discussion. Complete material on task analysis procedures and methodology may be obtained from the American Institute of Research, Pittsburg, Pennsylvania, "A Method for Man-Machine Task Analysis," by R. B. Miller 1953. The primary authors in this field are R. B. Miller and J. D. Folley, Jr. (Reference 3 shows 30 separate documents bearing on the subject all of which carry R. B. Miller's name as the author or co-author).

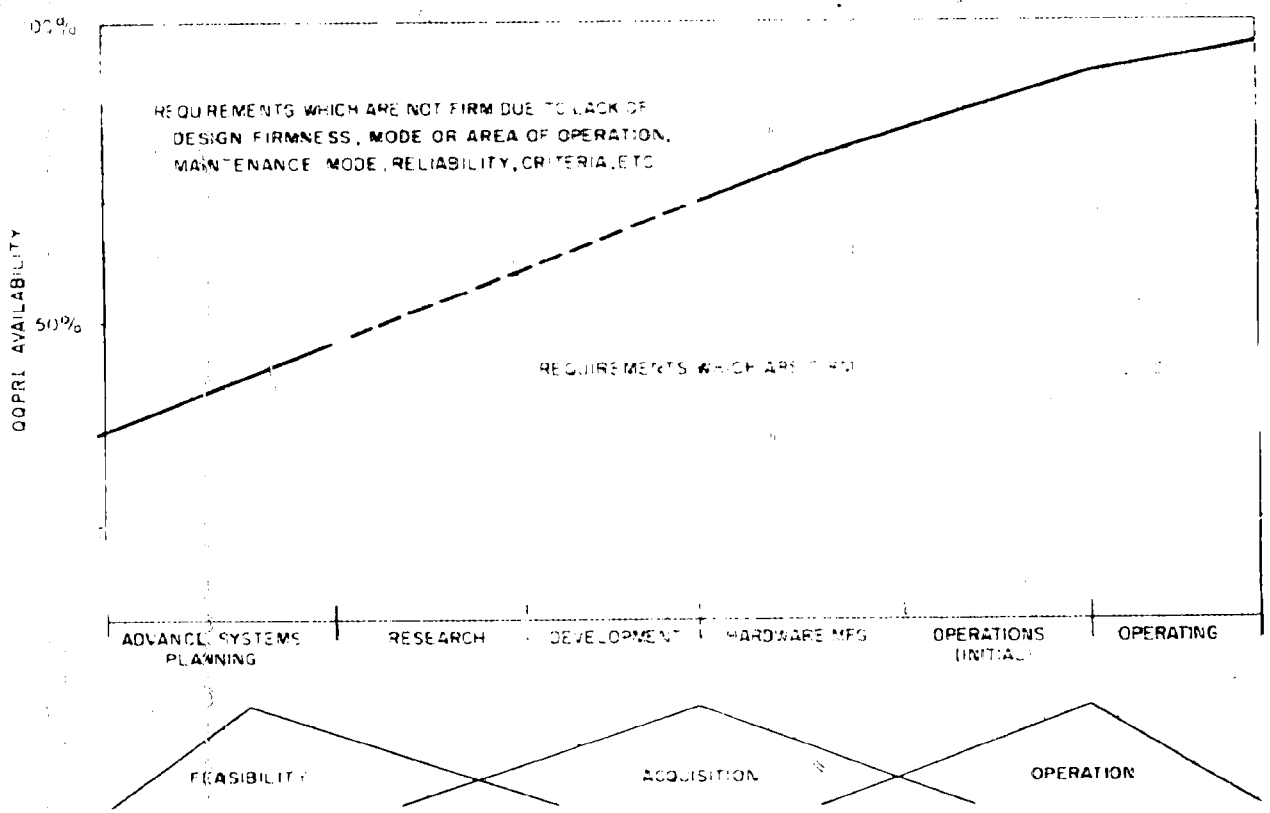
b. Applicable Documents

Recently published literature that is related to manpower prediction techniques or methodology, and applicable in the prototype, manufacture and test stage of weapons system development, include the following:

Reference 11 - "Methods for Computing Manpower Requirements for Weapons Systems under Development," by various employees of Republic Aviation Corporation, August 1961. The article was published under the aegis of the Behavioral Sciences Laboratory, Aerospace Medical Laboratory, ASD, AFSC, (TR 61-361).

The abstract published with this report states "A method has been developed for an accurate and comprehensive forecasting of manpower requirements for new weapon systems." The text devotes itself to the normal task analysis techniques utilizing worksheets for summarization. The method infers that subcontractor's components designs and engineering drawings are available. New techniques or new methods of predicting manpower requirements are not apparent in the content.

References 12, 14, and 15 - "The Validation of Predictions Concerning Personnel and Training Requirements," by Murray Glanzer and Robert Glaser, August 1958, "Methods of Forecasting Maintenance Job Requirements," by Robert M. Gagne and "Anticipating Tomorrow's Maintenance Job," by Robert B. Miller, respectively, devote their text to prototype and test phase of a weapons system development. They agree that valid



Hypothetical degrees of accuracy in prediction of QQPRI at successive stages of a weapon system development. (may be plus or minus)

Figure 1. Manpower Prediction

estimates of manpower requirements can be forecasted by utilizing the information available at the prototype stage.

Glanzer and Glaser (Reference 12) conducted a case study of training requirements for the Terrier Missile and compared the requirements developed by use of prototype material with actual requirements five years later. Gagne (Reference 14) concerns himself with interpretations of terms relating to job descriptions. Miller (Reference 15) selected the AN/APQ Radar Set and a Bombing-Navigation System for his study. Maintenance job requirements were developed using information available at the prototype stage and compared to actual requirements.

Reference 13 - "Automated Maintenance: Theory, Practice, and Implications for Training," by Paul E. Franks and Clarence W. Furnish, August 1960. Although the subject of this paper is training, parts of it are devoted to manpower requirements. The authors believe that one of the main reasons for adopting "automated checkout equipment" is to reduce the demand for large numbers of skilled men. They state that very little evidence exists to substantiate or refute this premise and that Air Force has not, to date, realized manpower reduction by using semi-automated maintence techniques.

Reference 16 - "A Technique of Job Activity Description for New Weapons Systems," J. T. Ray, December 1957. This report shows in detail a procedure for preparing a task equipment analysis by utilization of information at hand and to fill in the gaps by using information relative to similar equipment if necessary.

Reference 17 - "Initial QPRI for Weapons System 200A," Richard W. Highland, September 1956. This report shows new postions in the AFSC generated by this weapon system, and is included in our literature survey as it sets forth much detail that is required in an initial QPRI.

Reference 18 - "A Suggested Guide to Position Structure," R. Miller, May 1956. This memorandum describes in detail a method for job structuring from the tasks and group of tasks within an organizational unit. A glossary of commonly used terms in QPRI development is included.

Reference 19 - "Implications of Air Force Personnel Information for Job Requirements," Francis D. Harding and Leland D. Brokaw, February 1958. This report presents information relating to aptitude indexes, some job descriptions and a table of typical intelligence levels for some selected occupations.

Reference 20 - "A Report of QPRI for Weapons System No. 130A," John T. Larkins, March 1957. This is similar to Reference 17.

The publications summarized above represent the currently available literature applicable directly or indirectly to manpower estimating or prediction techniques at the prototype, manufacture and test stage of weapons system development.

d. Operational Stage

a. General Discussion

During this stage, the manpower requirements are more accurately refined and defined by the continual revision and updating of the OQPRI and other related documents. From the time the first unit has been turned over until the last unit is added to the new truly operational weapon system, the last remaining adjustments in system manpower requirements are made. At this point, new manpower requirements are a matter of attrition rates due to enlistment terminations, policy decisions, and numerous other factors effecting personnel turnover, and are reflected in Unit Manning Documents, Organization Tables and other Military Manpower Documents.

b. Applicable Documents and Summary

Recent published literature related to manpower prediction techniques or methodology in the operations stage of weapons system development include the following.

Reference 21 - "Feasibility of a Method for Estimating Short Term and Long Term Effects of Policy Decisions on the Airman Personnel System," by John W. Merck and Frank P. Ford, June 1959.

Reference 22 - "Influence of Resource and Policy Changes on Aircraft Capabilities," by Chauncy F. Bell, August 1961.

Reference 28 - "A Concept of Stability in Manpower Planning" W. Gorham and H. E. Scarf.

The foregoing publications treat with matters of policy and their effect on personnel subsystems. Merck and Ford (Reference 21) present a model which simulates the flow of airmen through the Air Force Personnel System under a given set of policies. This model makes it possible to gauge the effects of the policies at future points in time on grade levels, career fields, or any other resultant, if the input information is built into the model. Bell (Reference 22) also presents a model which provides for input information, i.e., change in flying program, change of ground alert requirement, change of workshift policy, Output information of reduced or increased manpower requirement is shown on charts. Gorham and Scarf's paper (Reference 28) is an academic exercise which sets forth a mathematical model upon which a stable state of personnel skill level distribution can be achieved. As the title suggests, it is a concept which conceives a military force with a stable environment, i.e., size of force is constant, enlistment period does not vary, re-enlistment and retention rates are stable.

Reference 23 - "Application of a Systems Concept to Personnel Research," by Omer Lucien, Myron A. Fischl, and Douglas Courtney, August 1958. This document is not directly applicable to the study program for which this report is intended. It is included herein as it does have indirect application to a primary evaluation technique, namely "Feedback". The document dwells on "feedback", its history, and states how useful it would be if employed in the Navy personnel system.

Reference 24 - "OPRI for C-130 Combat Air Transport System," by Irl A. Irwin and Robert F. Dice, February 1956. This report is included in our survey because of its excellent content regarding position information, system description and manning information. Recommendation is made in the report to change some task requirements so as to spread the work load from some busy AFSC's to those who have very little to do.

Reference 25 - "A Technique for Displaying Task Analysis Information," Robert L. Weislogel and T. Owen Jacobs, March 1956. This report shows a display technique by use of plastic overlay pages.

Reference 26 - "Rater Tendencies in Estimating Qualifications Required by Air Force Jobs," L. Wiley, H.B. Harber, M.J. Giorgia, September 1959. This report concludes that the individuals who rate other individuals have personal tendencies. One such tendency is to use or refrain from using the extremes of a rating scale depending on the rater.

Reference 27 - "A Method for Estimating Direct Squadron Maintenance Malfunction Rates," Bernard Voosen, April 1958. This research memorandum makes a comparison of the personnel necessary to operate, maintain and repair a weapons system using a remove and replace mode with the manpower necessary when a different mode of maintenance is employed. The conclusion is made that a saving of manpower is accomplished by use of the remove and replace mode. The model used establishes its own concepts for operation, maintenance, repair time, etc., not the actual mode or concept. This research memorandum does contribute to the field of literature in prediction or estimation methodology as it explores a different way to accomplish the same result in the maintenance and repair area.

Reference 29 - "Evaluation of the QPRI for Weapons System 115A," Glory A. Sturiale, 3 February 1960. This evaluation report is very critical of both the contractor and the format of the QPRI.

Reference 30 - "A Survey of the Literature on Prediction of Air Force Personnel Requirements," John D. Foley, Jr., Jean B. Fairman, Edna M. Jones, July 1960. A survey of methods for predicting personnel requirements for future Air Force weapon systems is presented with abstracts of 121 unclassified, professional documents. Emphasis is placed on identifying procedures for deriving personnel requirements information, and the supporting rationales. The current state-of-the-art is evaluated and presented with implications for future research requirements. Conclusions from the study show that fairly thorough procedures exist for describing tasks and positions and for combining tasks into positions. However, no evidence was found of any systematic evaluation of this method. Estimating manpower requirements often has been done but only one report describes a procedure for doing this. Determining skill level requirements and criticality of tasks has received little methodological attention. Most attention has

been directed toward the rating of skill levels rather than toward any objective determination of skill requirements. One exception provides a seven-point scale of operationally defined performance levels. This publication is invaluable for personnel engaged in preparing Task Analysis. It is a thorough professional presentation containing 384 pages. Ironically, like the other techniques found in this survey, this one has never been evaluated.

The publications summarized above represent the current literature made available in this literature search and survey which are applicable directly or indirectly to manpower estimating or prediction techniques at the Operating Stage of Weapons System Development.

5. General

The most recently published literature survey, "A Survey of the Literature on Prediction of Air Force Personnel Requirements," by Foley, Fairman, and Jones, July 1960, presented the following Summary of Results:

Summary of Results

In summary, then, we can conclude the following about the state-of-the-art in predicting Air Force personnel requirements for weapon systems, as revealed by this survey of the literature.

1. Fairly thorough procedures exist for describing positions and tasks. These procedures, or some modifications of them, have been used extensively. No evidence was found of any systematic attempts to evaluate the procedures to identify their strong and weak points.

2. There exists a procedure for combining tasks into positions. Once again, no evidence was found of any systematic evaluation of this method.

3. Estimating manpower requirements has often been done. Only one report attempts to provide a procedure for doing this. This method has apparently never been formally evaluated.

4. Determining skill level requirements has received little methodological attention. Most attention seems to have been directed at the rating of skill levels rather than at any objective determination of requirements. One exception provides a seven-point scale of operationally-defined performance levels. Like the other techniques found in this survey, this one has never been evaluated.

The foregoing summary is still applicable excepting paragraph 3. The literature search and survey conducted under this present study discloses three publications, References 1, 2, and 5, which provide a procedure for estimating manpower requirements at the advanced planning stage, one publication, Reference 11, which provides the same at the prototype stage of weapons system development, and another, Reference 27, which may be used in specialized areas. Also, the statements regarding evaluation are not all applicable as the literature search and survey conducted under this present study disclosed that attempts to evaluate manpower estimating techniques had been attempted. Glanzer and Glaser (Reference 12), and Robert B. Miller (Reference 15) compared requirements which were based on data available at the prototype stage with actual requirements and evaluated the results. Robert M. Gagne (Reference 14), also evaluated the technique of utilizing data available at the development stage.

The literature search and survey conducted under this present survey included the very excellent material published in the form of Air Force Manuals as this material is the base from which all manpower prediction technique relating to Air Force Weapons Systems must start. The recent updating of AFM 26-1 Reference 4, the addition of many new factors in AFM 172-3 are among the many positive contributions which advance the state-of-the-art.

The updated Handbook of Instructions for Aerospace Personnel Subsystems Designers, Reference 7 is another contribution which, if properly sustained, can be beneficial for producing better estimates.

Specific attention is directed to References 8 and 13 of the bibliography and to the conclusions of the authors. If their conclusions

that expected manpower savings were not effected through use of automated equipments have merit, further validation by research appears warranted.

Attention is also directed to Reference 29 of the bibliography. This report was prepared by a Human Factors Project Officer and reviewed and approved by the Chief, Missile Test Division, AFFTC. Quoted from two sections of the report is the following:

Section III Results

B. Accuracy of Estimates of Time Required for Task Completion

AFBM Exhibit 58-18C, dated 12 October 1959, specifies the requirement that an estimate be provided "of the amount of time, in hours and/or decimal fractions of an hour, required to accomplish each duty . . ." While there is a column in the QPRI headed "Freq and Time," no time estimates are given for completion of tasks. The question arises, however, as to whether this information should be included in a QPRI, and, secondly, what purpose it would serve. (Underlining added)

For purposes of determining manning requirements, time estimates for each task would hardly be of value. The QPRI includes a breakdown of manning estimates by position title, AFSC and job category for a squadron. An operational squadron could easily match its needs against these proposed manning estimates to determine their accuracy.

As for using these time estimates for training purposes, such data would seem to be available through the use of the hardware analysis program and the unit proficiency system. As defined in Exhibit 57-7, "Hardware Analysis Program for Ballistic Missile Weapon Systems and Advanced Space Systems," dated 1 June 1959, this program is to provide qualitative and quantitative personnel information and integrated weapon systems training requirements information. This data includes man-hour requirements for

performance of inspections, remove and replace action, repair, adjustment calibration, checkout and system verification, etc. This breakdown of hardware maintenance includes many of the essential tasks and duties which can logically be isolated and analyzed in terms of time for either operational or training purposes.

Time estimates for representative tasks within a ballistic missile squadron are also provided for under the unit proficiency system. These data are supplied by both prime and subcontractors. Time estimates are in terms of scoring standards, performance being measured in part by time required to complete task. These estimates can be used for measuring performance, i.e., the unit proficiency capability, and also for determining training needs and requirements. It is doubtful whether time estimates for each detailed task would ever be used by an operational squadron for training purposes or for measuring proficiency. For example, one position description lists over 150 separate tasks or duties. The breakdown of larger task groupings within the hardware analysis program and the unit proficiency system would appear to permit a much more feasible and measurable unit with which to work.

Section IV Conclusions

B. Accuracy of Time Estimates for Task Completion

Frequency-of-task is given in the QPRI, but these frequency estimates lack accuracy. Frequency per unit of equipment is never indicated as "per shift." Instead, "as required" or "daily" are the terms used, and their use appears arbitrary.

Time estimates are not given in the QPRI. However, this requirement doesn't seem to fall within the scope of the QPRI, and consideration should be given toward deleting this requirement from Exhibit 58-18C. This information is of questionable value for manning purposes. And as for training purposes, such data would

be available through the use of the hardware analysis program and the unit proficiency system. Time estimates are more specifically relevant to task analysis.

If the foregoing criticism of QPRI Exhibit 58-18C Requirements has merit, an area for cost saving is apparent.

Progress Report No. 1 of this Study which was submitted to Col. H.F. Bunze, BSD USAF on 27 March 1963 by V. Josephson of Aerospace Corporation contained the following information in Section A, Paragraph 2.

> "The data ('Manpower Requirement Data') is 'called out' under a military specification, such as MIL Specification QPRI 26239A. Information submitted under this requirement is related only to the peculiar equipments being developed so that the quantity and qualifications are very specific. Interfaces between subcomponent, components, subsystems and the weapons system as a whole are considered; however, the specifications are in a sense restrictive so that a minimal manning requirement is obtained at this stage of development ('The Research and Development Stage') by the Contractor. A more realistic quantitative and qualitative report could be produced, if the specifications required an estimate which was not restricted to the pecular equipment being developed, but were broadened to include all equipments necessary for complete operation, maintenance, etc. of the system."

Investigation relative to the foregoing criticism of MIL Specification QPRI 26239A is warranted, unless the sequence of aggregation of QPRI data provides of inclusion of the personnel requirements not included in the basic QPRI data.

IV. CONCLUSIONS AND RECOMMENDATIONS

A. Conclusion

Based on the literature survey which has been conducted in accordance with the study plan outlined in Paragraph III-B of this report, the publication of the additional literature; (References 1, 2, 5, 11, and 12 of the bibliography which are discussed in Section III of this report), can be categorized as an addition to the state-of-the-art of manpower prediction techniques.

No evidence has been found that the techniques stated in this literature have been formally used for estimating manpower requirements for a specific weapons system, or that the techniques have been systematically evaluated. Until these techniques are evaluated, no firm conclusion as to their merit can be reached.

The validity of manpower predictions utilizing information generated at the prototype stage of weapons system development is confirmed by three publications. The extent of the investigation by the authors was limited to certain functional areas. Until more extensive investigation is undertaken and more confirmations appear, a positive evaluation cannot be made.

The excellent military publications, in the form of manuals, (References 3, 4, and 7 of the bibliography), are positive contributions to the state-of-the-art The continued updating of these publications should be implemented. However it must be recognized that most of these manuals state what is required; not how it is accomplished.

The conclusion reached by one author (Reference 13 of the bibliography) and confirmed by another publication (Reference 8 of the bibliography), present a sound basis for the exercise of caution when predicting a manpower saving because "automated equipment" is used in the weapons system.

B. Recommendations, Plans for Future Research

The study plan as summarized in Paragraph III-B of this report is partially complete with respect to Task 1, Literature Survey. It is recommended that Task 2, Data Collection be undertaken utilizing to the extent possible all existing resources, with planning support and direction from human factor and personnel subsystems specialists.

It is recommended that concurrently with the execution of Task 2 effort be made to extend Task 1. The field survey undoubtedly will disclose unpublished literature, procedures, and new technique and methodology regarding the manpower prediction techniques as used in actual prediction efforts on specific weapons systems, without which the entire study has little if any validity.

Task 3 under the study plan, Evaluation of Techniques and Results would appear to fit within the technical scope of manpower planning specialists in the personnel subsystem design area. A preliminary survey of the results of Task 2 effort would direct and affect the future research plan. The acceptability of the data produced by the field survey effort for valid statistical analysis would appear to be the directive characteristic. Also decisions with regard to the format of Publication of Findings, Task 4 under the study plan, should be deferred until a preliminary survey of the results of the data collection task are evaluated.

The literature search and survey disclosed the following areas wherein additional research may be recommended which were not a part of the original study plan.

1. The requirements of MIL Specification QPRI 26239A are restricted to the specific equipments under development. Conduct additional research to determine if all qualitative and quantitative personnel requirements are understated because of this unvalidated statement, or if all interface personnel requirements are included when the systematic aggregation of QQPRI is completed.

2. The requirements of AFBM Exhibit 58-18C include the request for details regarding time required for task completion, which are unnecessary. Conduct additional research to determine if the request for the inclusion of this detail is in fact unnecessary or if the user is not utilizing the information as intended.

3. The Air Force has not, to date, realized predicted manpower reduction by using semi-automated maintenance techniques, and the use of automated equipment does not produce the expected manpower saving.

A recommendation that research be conducted to validate or disprove the above conclusions reached by one author and confirmation by another would appear justifiable.

Bibliography - Personnel Subsystems Research (Manpower)

Title	Author	Source	Number	Date	Class	Comments
The Air Force Personnel Subsystems Concept	Gustafson	WPAFB		6/62	U	Not abstr.
Anticipatin Tomorrow's Maintenance Job	R. Miller	Human Resources Research Center, Chanute AFB	Research Review 53-1	1/53	U	Abstr.
Application of a Systems Concept to Personnel Research (Final Report)	O. Lucier	Courtesy and Company	Report No. 22	8/58		Abstr.
Automated Maintenance, Theory, Practice and Implications for Training	P. Franks	WADD	TR 60-412	1960	U	Abstr.
Automation and Personnel Requirements for Guided Missile Ground System Functions	W. Knowles	General Electric	WADC TR 59-240	5/59	U	Abstr.
Collecting and Compiling Task Information for Newly Developed Guided Missiles	R. Glaser	American Institute for Research	Tech. Bul. 53-2 Pt. 1	8/53	C	Abstr.
A Concept of Stability in Manpower Planning	W. Gorham H. Scarf	Rand Corp.	P-1193	9/27/57	U	Abstr.
Concepts for Estimating Air Force Manpower Requirements for Planning	Heuston	Rand Corp.	RM 2611	11/1/60	U	Abstr.
Contractual Requirements Recording Analysis, and Management Programming Documentation Manual		STL		12/62		Not rec.

Bibliography: Personnel Subsystems Research Manpower [illegible]

Title	Author	Source	Identifier	Date	Class	Comments
A Data Reduction Technique Applied to the Development of QQPRI: The Keysort Card System	Gael Sidney Stackfleth	WADD	TN [illegible]	5/57	U	Not abstr
Development of Prototype Task Equipment Analysis		Lockheed Marietta, Ga		10/56	U	Not rec
Development of QQPRI		WPAFB				Not abstr
Dynamic Analysis of Manpower Requirements on a Digital Computer	G. Vacherot J. Teeple	Operations Research Society of America		10/56	U	Not rec
The Effects of Task Organization, Training Time, and Retention Interval on the Retention of Skill	J. Naylor	Ohio State University	AMRL TDR-62-7	9/62	U	Not rec
An Empirical Study of the Job Component Checklist	R. Gunn	AF Personnel and Training Research Center Lackland AFB	TN 56-124	12/56	U	Not appli
Estimating Personnel and Equipment Requirements	Haythorne	Rand Corp.	R-178		U	Not rec
Evaluation of the Qualitative Personnel Requirements Information for WS 155A	G. Sturiale	Edwards AFB		2/15/56		Abstr
Evaluation of a Technique for Characterizing the Job Requirements of Selected Air Force Jobs		Columbia University	Quarterly Rpts 1, 3 and 9	9/54 6/55 12/56	U	Not appli

Bibliography - Personnel Subsystems Research (Manpower)(Continued)

Title	Author	Source	Number	Date	Class	Comments
Feasibility of a Method for Estimating Short-Term and Long-Term Effects of Policy Decisions on the Airman Personnel System	Merck	WADC	TR 59-38	6/59	U	Abstr.
Function and Task Analysis as a Weapon System Development Tool	D. Erickson G. Rabidoau	Northrop	57-1148	10/57		Not avail. from Northrop or ASD
Handbook of Instructions for Aerospace Personnel Subsystem Designers		USAF	AFSCM 80-3	Updated period.	U	Abstr.
Human Factors Guide		Boeing	D2-9077-2	6/62	U	Not appli.
The Identification and Description of Some Critical Aircrew Job Requirements	C. Hahn	Randolph AFB		2/54	U	Not appli.
Implications of Air Force Personnel Information for Job Requirements	F. Harding	Lackland AFB	TM 58-3	2/58	U	Abstr.
Influence of Resource Policy Changes on Aircraft Capabilities	C. Bell	Rand Corp	R-382	1961	U	Not appli.
Initial QPRI for Weapon System 200A (IM-99) Bomarc	R. Highland	Lackland AFB	TN 56-116	9/56	U	Abstr.
Knowledge of Results in a Monitoring Task		AMRL	TDR 62-82	8/62	U	Abstr.
Manpower Implications of Some Air Force Space Systems		Rand Corp	61-7126	2/62	S	Not rec.
Manpower Planning Factors for Air Force Space Systems in the Concept Stages of Development	M. Heuston	Rand Corp	RM 2823 PR	2/62	C	Abstr.

Bibliography - Personnel, Training, Systems Research, Manpower (Continued)

Title	Author	Source	Number	Date	Class	Comments
Manpower Planning Factors for Undersea and ICBM		Rand Corp	RM [illegible]			Not abstr.
Methods for Computing Manpower Requirements for Weapon Systems Under Development	J. Lowee	Republic Aviation	TR 61-361	8/61	U	Abstr.
A Method for Estimating Direct Squadron Personnel via Malfunction Rates - Titan ICBM		Rand Corp	RM [illegible]-1	11/57	S	Abstr.
Methods of Forecasting Maintenance Job Requirements	R. Gagne	Asst. Secy. of Defense		None	U	Abstr.
A Method for Man-Machine Task Analysis	R. Miller	American Institute for Research	TR 53-137	6/53	U	Not rec.
Methods of Recording and Reporting Task Analysis Information	M. Snyder	State College Penn.	Special Pub No. 16	10/59	U	Not abstr.
Personnel Planning Information		SSD	SSD Exhibit 61-94	1961	U	Not rec.
Personnel Planning Information for the Air Force Satellite Control System	M. Hill K. Lindsay	SSD	TDR 62-21	2/62	U	Abstr.
Personnel Psychology	M. Jones	Office of Naval Research	TR [illegible]	1953	U	Not appli.
Policy and Criteria			AFM 26-1		U	Abstr.
A Preliminary Study of Informal Crew Conferences as a Crew Training Adjunct	B. Levy	Lackland AFB	TR 54-87	1954	U	Not appli

Bibliography - Personnel Subsystems Research (Manpower)(Continued)

Title	Author	Source	Number	Date	Class	Comments
Preparation of Position-Task Equipment Analysis for Weapon Systems - Introduction	J. Ray	Lockheed, Marietta, Ga.		4/57	U	Not rec.
Procedure for Determining USAF Estimated Manpower Requirements	J. Powell	Aerospace		Updated period.		Abstr.
QPRI for C-130 Combat Air Transport System	I. Irwin	Lackland AFB	TN 56-45	2/56	U	Abstr.
Qualitative Personnel Requirements Information (107A-2) Atlas		Martin	WDD-M-SR-58-5	4/58	S	Not abstr.
Qualitative Personnel Requirements Information Report for WS315A (Thor)		Douglas		5/58	S	Not rec.
Qualitative Personnel Requirements Information for WS107A-1 (Atlas)		AFBMD		4/58		Not rec.
Qualitative Personnel Requirements Information Report for WS315A (Thor)		Douglas		11/56	S	Not rec.
Rater Tendencies in Estimating Qualifications Required by Air Force Jobs	L. Wiley	Lackland AFB	TN 59-195	9/59	U	Abstr.
Reference Manual for QPRI		WPAFB			U	Request cancelled. Superseded by MIL-Q-26239
A Report of Job Analysis	A. Kershner	Office of Naval Research	ACR-5	1955	U	Not appli.

Bibliography - Personnel Subsystems Research (Manpower) (Continued)

Title	Author	Source	Number	Date	Class	Comments
A Report of QPRI for WS101A (SM-62) Snark	J. Larkins	Lackland AFB	TN 57-38	1/57	C	Abstr.
Second Special Report on Cost Studies	D. VanTijn	ARINC Research Corp		1/62	U	Abstr.
The Standard Maintenance Form, Its Purpose, Development and Use	R. Miller	American Institute for Research		2/54	U	Not abstr.
A Study of Methods for Determining Skill, Knowledge and Ability Requirements of Newly Developed Equipment	R. Miller	American Institute for Research		6/53	U	Abstr.
A Suggested Guide to Position Structure	R. Miller	American Institute for Research	TM 56-13	5/56	U	Abstr.
Summary of Research on Air Force Management and Support		Rand Corp	S-12			Not abstr.
The Support of Future Weapons	C. Zwick	Rand Corp	P-1787	9/59	U	Abstr.
A Survey of Personnel and Training Research in Government Business and Industry	C. Hahn	Lackland AFB	TR 53-22	7/53	U	Abstr.
A Survey of the Literature on Prediction of Air Force Personnel Requirements	J. Folley	WADD	TR 60-493	1960	U	Abstr.
A Survey of Potential Morale, Motivation and Retention Problems at Ballistic Missile Sites		WADC	TN 58-66	1958	U	Not appli.

Title	Author	Source	Number	Date	Class	Comments
Technical Data Requirements for Systems Engineering and Support	T. Walton	STL		1961	U	Not applic.
A Technique for Displaying Task Analysis Information	R. Weislogel T. Jacobs	Kirtland AFB	TN 56-15	2/56	U	Abstr.
A Technique of Job Activity Description for New Weapon Systems: Task Equipment Analysis	J. Ray	American Institute for Research	TR 57-11	12/57	U	Abstr.
Training Equipment Characteristics for Proficiency Training - SM 65		Lackland AFB	TN 57-18	1957	C	Abstr.
Training of Potential Astronauts	C. Yeager W. Schweikhard	EAFB	63-ANGT-33	1/63	U	Not abstr.
Use of System Analysis Methods for Predicting Job Requirements from Prototype Equipment	R. Miller	American Institute for Research		9/51	U	Library unable to locate
The Validation of Predictions Concerning Personnel and Training Requirements	M. Glanzer R. Glazer	American Institute for Research		8/58	U	Abstr.
Weapon System Development Procedures as Related to Qualitative Personnel Requirements	R. Dice	WPAFB		8/54	U	Request cancelled. Library unable to locate.

Reference 1

Author: M. C. Heuston

Title: Concepts for Estimating Air Force Manpower Requirements for Planning Purposes

Agency: Rand Corporation

Publication Date: 1 November 1960

ABSTRACT:

This memorandum discusses basic concepts for planning manpower requirements on current and advanced weapons systems with emphasis on advanced systems at the R and D phase.

The philosophy emphasizes total system requirement. It uses the ARDC personnel subsystem concept for the framework on which to build estimates.

The primary objective is to provide sequential procedures to arrive at quantitative requirement for use of planners. The use of these procedures is at the R and D phase and is intended to be well in advance of any official QPRI information.

It also defines "personnel subsystem" and "manpower requirements" and contains a check list of functional groups.

Comments: A good useful publication.

Reviewed by: J. C. Powell

Reference 2

Author: M. C. Heuston

Title: Manpower Planning Factors for Air Force Space Systems in the Conceptual Stages of Development

Agency: Rand Corporation

Publication Date: February 1966

ABSTRACT:

This memorandum presents a list of planning factors for the estimation of gross manpower requirements for the operation, maintenance and support of Air Force Space Systems and describes general procedures for applying these factors to any particular space system study. Is useful to analysts and planners at early stages of development.

Comments: A good useful publication. Lists categories not now in use but which will be used in the future.

Reviewed by.

Reference 3

Author: None

Title: USAF Planning Factors (Vols 1 and 2 AFM 172-3)
Title unclassified - Contents classified.

Agency: Department of the Air Force

Publication Date: May 1962 and updated at intervals.

ABSTRACT:

Although security restrictions do not preclude the making of suitable extracts when they can be made without jeopardizing security, no extraction of contents is made in this abstract or in the report of which this abstract is a part.

The information regarding factors, ratios, crew composition and other data applicable to personnel requirements contained in this publication are invaluable to planning personnel.

Comments: The availability of these documents to manpower planning personnel and utilization of this information by them will provide the basis for better techniques and results.

Reviewed by: J. C. Powell

Reference 4

Author: None

Title: Manpower Policy and Criteria (AFM 26-1)

Agency: Department of the Air Force

Publication Date: Updated at intervals

ABSTRACT

This loose leaf manual outlines the broad policy and procedures for management of Air Force manpower resources. The manual includes manpower programming, distribution by skill levels and grades, utilization of civilians, and man-year standards.

Detailed information is given regarding functions, a list of functional categories is provided with codes that can be utilized in checking organization tables.

The manual also shows Air Force-wide distribution by functions in a somewhat obscure manner.

Comments: This publication is a must for planning Air Force requirements. If updated, it would be invaluable. Weakness is the age of the detail.

Reviewed by: J. C. Powell

Reference 5

Author: John C. Powell

Title: Procedure for Determining USAF Estimated Manpower Requirements

Agency: Aerospace Corporation

Publication Date: Updated periodically.

ABSTRACT:

A manual for the use of planners and analysts which sets forth a sequential work procedure when estimating manpower requirements. It provides some charts, tables, lists and statistical information.

The intent of this in-house publication is to provide for orderliness and require back-up data in the form of work papers when estimating.

Comments: Very useful to have on hand when someone asks, "How did you arrive at this result?"

Reviewed by: J. C. Powell

Reference 6

Author: T. F. Walton

Title: Technical Data Requirements for Systems Engineering and Support

Agency: Space Technology Laboratories, Inc.

Publication Date: 1964

ABSTRACT:

A complete factual publication on systems engineering which embraces the entire subject in depth.

Received, circa 1964 by T. F. Walton.

Deals with research, development, test, manufacturing, assembly and checkout facilities and specifications. The chapter headings are: System Program Requirements, Documenting the Systems Functional Analysis and Maintenance Analysis, Source Data Development and Control, Hardware and Facilities Specifications, COPRI Data, Training and Training Equipment Planning Data, Engineering Drawings and Associated Data Lists, Procedural Support Data, Spares Records and Reliability Data, Miscellaneous Data Requirements and Provisions, Production Control and Status Reporting, Quality Assurance Provisions for Data, Automation, Change Processing Revision, and Contracts.

Comments: Excellent. The chapter on COPRI Data is pertinent to our subject and the techniques shown are basic.

Recommended by J. C. Powell

Reference 7

Author:

Title: Handbook of Instructions for Aerospace Personnel Subsystem Designers (AFSCM 80-3)

Agency: USAF

Publication Date: Updated periodically.

ABSTRACT:

This loose leaf manual is the primary source for information relating to personnel subsystem design.

It contains guidance material for all individuals working in the area of human factors connected with Air Force Weapons Systems and is directed to the level of principles, philosophy and policy rather than to details.

The contents cover the application of human engineering to systems design; estimating qualitative and quantitative personnel requirements; planning designing and developing training equipment and training programs; the preparation of training manuals for operator and maintenance personnel; and criteria for the continuing of personnel subsystems work until complete development of the weapon system.

Comments: A must for all hands.

Reviewed by: J. C. Powell

Reference 8

Author: W. B. Knowles

Title: Automation and Personnel Requirements for Guided Missile Ground Support Functions

Agency: Aerospace Medical Laboratory, WADC, ARDC

Publication Date: May 1959

ABSTRACT:

This study was started because personnel requirements were not declining with the use of automatic electronic ground equipment as had been expected. The objective of the study was to find out why and recommend steps to make the use of automatic equipment pay off in reduced demands for the high skill level manpower which this equipment requires.

Results of the study showed that automation had not reduced manpower usage because (1) testing and maintenance requirements and objectives were not systematically defined and (2) manual operations were not completely described or programmed. Recommendations were (1) that a "maintenance system" design approach be used and (2) that further research be conducted in development of techniques for evaluating the design of test logic, maintenance operations, and manual tasks.

Comments: An excellent, high level, word picture of the problem. The recommendations are mature.

Reviewed By: J. C. Powell

Reference 9

Author: Robert Glaser

Title: Collecting and Compiling Task Information for Newly Developed Guided Missiles

Agency: AIR

Publication Date: August 1953

ABSTRACT:

This report presents a compilation of task information regarding the Terrier Missile and recommendations and considerations for collecting task information.

It also shows sample forms and procedural steps for the processing of task data, and explains the meaning of terms such as: task summary, sub tasks and behaviors, cues available for task performance, major decisions, time required and numerous other terms.

Comments: This is a Navy oriented publication. Is very useful for personnel who perform task analysis functions.

Reviewed by: J. C. Powell

Reference 10

Author: M. V. Hill and K. J. Lindsay

Title: Personnel Planning Information for the Air Force Satellite Control System

Agency: SSD, AFSC

Publication Date:

ABSTRACT:

A general concept of the personnel requirements forecasting problem is developed. The differences between forecasting for the Air Force Satellite Control System (an R and D system) and for an "operational" system are delineated. A detailed comparison of the differences between Personnel Planning Information (AF/SSD Exhibit 61-94) and Qualitative and Quantitative Personnel Requirements Information (MIL-D-26239A) is presented.

Comments: None

Reviewed by: J. C. Powell

Reference 11

Author: Various employees of Republic Aviation Corporation

Title: Methods for Computing Manpower Requirements for Weapons Systems Under Development

Agency: Behavioral Sciences Laboratory, Aerospace Medical Laboratory ASD-AFSC

Publication Date: August 1961

ABSTRACT:

ASD TR 61-361 - Republic Aviation Corp., Farmingdale, Long Island, N. Y. Methods for Computing Manpower Requirements for Weapon Systems Under Development --

A method has been developed for an accurate and comprehensive forecasting of manpower requirements for new weapon systems. The manning estimate is developed through a series of integrated steps leading to position descriptions and numbers of men required.

Early training information is obtained directly from Task Equipment Analyses; information covering ground support and other equipment, spares and consumables is obtained as a by-product. Plans are presented for an approximation of the effect of environment upon manning requirements for the determination of man-hours required for work of a type not amenable to direct task analysis, and for the estimation of maintenance activity frequency rates.

Comments: The title suggests methods for computing manpower requirements for weapons systems "under development." The text of the report infers that engineering drawings and "subcontractors component designs" are available prior to preparation of task equipment analysis worksheets.

Reviewed by: J. C. Powell

Reference 12

Author: Murray Glanzer and Robert Glaser

Title: The Validation of Predictions Concerning Personnel and Training Requirements

Agency: American Institute for Research

Publication Date: August 1958

ABSTRACT:

This is a case study of training requirements for Terrier Missile. Data which was prepared "early" in the system development, such as "Task Analysis Evaluation Booklet" and "Proficiency Test Material," was compared as to its applicability five years later.

The conclusion was, in general, that material developed on the basis of a prototype system remains applicable with minor modifications over a five-year period.

Comments: None

Reviewed by: J. C. Powell

Reference 13

Author: Paul E. Franks and Clarence W. Furnish

Title: Automated Maintenance: Theory, Practice, and Implications for Training

Agency: WADD 60-412

Publication Date: August 1960

ABSTRACT:

The authors believe that one of the main reasons for adopting an "automated checkout of equipment" concept is to reduce the demand for large numbers of highly skilled men. They state though, that even if this premise does appear logical, very little evidence exists to substantiate or refute it. The report also states, "The fact that the Air Force has not, to date, realized manpower reductions by using semiautomated maintenance techniques raises the question of whether it is using proper man-machine relationships in regard to ACDE." This section of the report concludes that efforts should be concentrated in this area.

Comments: We have abstracted those parts of this report which relate to manpower requirements. The primary subject is training. A good publication.

Reviewed by: J. C. Powell

Reference 14

Author: Robert M. Gagne

Title: Methods of Forecasting Maintenance Job Requirements

Agency: Air Force Personnel and Training Research Center

Publication Date: None

ABSTRACT:

This paper concerns itself with interpretation of terms relating to job descriptions. The author agrees with other analysts in this field that job requirements can be predicted by use of development models if the production model is basically the same as the development model.

Comments: None

Reviewed by: J. C. Powell

Reference 15

Author: Robert B. Miller

Title: Anticipating Tomorrow's Maintenance Job

Agency: ATC

Publication Date: March 1953

ABSTRACT:

The research covered by this report is directed primarily to development of methods for anticipating job requirements prior to production of the equipment. The use of the information is to permit early training.

The AN/APQ-24 Radar Set and a Bombing-Navigational System were selected for the study.

The "actual" maintenance requirements were developed. Requirements were also developed using the prototypes. Comparison of actual versus prototype lead to the conclusion that requirements were similar.

Comments: None

Reviewed by: J. C. Powell

Reference 16

Author: J. T. Ray et al

Title: A Technique of Job Activity Description for New Weapons Systems

Agency: USAF, AFP and TRC, Lackland AFB, Texas

Publication Date: December 1957

ABSTRACT:

This report shows in detail a procedure for preparing a task equipment analysis The procedure or technique is predicated on there being at hand QPRI information which shows lists of tasks to be performed. The tasks, however, have not been described. The technique requires other at hand information such as contractors plans and specifications. The primary "technique" is to construct detail descriptions from information at hand and utilize information relative to similar equipment, if necessary.

Comments: Is a good useful publication for any reader who requires knowledge as to preparation of task equipment analysis detail.

Reviewed by: J. C. Powell

Reference 17

Author: Richard W. Highland

Title: Initial Qualitative Personnel Requirements Information for Weapons System 200A (IM-99 Bomarc)

Agency: Boeing Airplane Company

Publication Date: September 1956

ABSTRACT:

This development report estimates the personnel associated with the maintenance and servicing of WS 200A. It shows in detail the tentative manning for selected positions only in an IM-99 Squadron of four flights, and also comments on other areas which will require manpower. Its primary intent is to show new positions generated by this weapons system.

Comments: This is another detailed report which delves into much detail regarding a segment of an area but does not attempt to predict manpower requirements for the entire area.

Reviewed by: J. C. Powell

Reference 18

Author: R. Miller

Title: A Suggested Guide to Position Structure

Agency: American Institute for Research

Publication Date: May 1956

ABSTRACT:

This memorandum describes in detail a method for job structuring from the tasks and groups of tasks within an organizational unit.

It outlines a Blackboard Test Procedure using a proponent, an opponent, and an umpire.

There is also included in the memorandum a usable glossary of commonly used terms in QPRI development.

Comments: A good publication for QPRI technicians.

Reviewed by: J. C. Powell

Reference 19

Author: Francis D. Harding and Leland D. Brokaw

Title: Implications of Air Force Personnel Information for Job Requirements

Agency: WADC, ARDC

Publication Date: February 1958

ABSTRACT:

This report presents information relating to aptitude indexes, some job descriptions and a table of typical intelligence levels for some selected occupations.

Comments: Title is misleading as to actual subject dealt with.

Reviewed by: J. C. Powell

Reference 20

Author: John T. Larkins

Title: A Report of Qualitative Personnel Requirements Information for Weapons System No. 104A (SM-62 Snark)

Agency: USAF, Lackland AFB

Publication Date: March 1957

ABSTRACT:

This is a standard development report for QPRI information. It lists "new" positions and gives position definitions.

Comments: None

Reviewed by: J. C. Powell

Reference 21

Author: John W. Merck and Frank B. Ford

Title: Feasibility of a Method for Estimating Short-Term and Long-Term Effects of Policy Decisions on the Airman Personnel System

Agency: WADC - ARDC

Publication Date: June 1959

ABSTRACT:

This report describes and indicates the utility of a model which simulates the flow of airmen through the Air Force personnel system under a given set of policies. This model makes it possible to estimate, with as much accuracy as is available in the input information, the effects of that set of policies at future points in time. These effects may be gauged in terms of the future distribution of grade levels, career fields, or other pertinent information which may be built into the model.

Comments: A good workable proof-tested method. Only weakness is the lack of historical data to provide basic input data. As the tabulating of statistical information improves this will provide an excellent model.

Reference 22

Author: Chauncy F. Bell

Title: Influence of Resource and Policy Changes on Aircraft Capabilities

Agency: Rand Corporation

Publication Date: August 1961

ABSTRACT:

This report examines the effects of changes in operational policies, maintenance policies and resources. A hypothetical weapon system (manned aircraft) is used as a model.

Operational policy changes are: change in flying program and change of ground alert requirement. Maintenance policy changes are: change of workshift policy and times of work, and change in scheduled workload. Resources are defined as the aircraft, the maintenance personnel, ground support equipment, facilities and spare parts.

The effects of changes are shown on charts. Some conclusions are made.

Comments: Well written.

Reviewed by: J. C. Powell

Reference 23

Author: Omer Lucier, Myron A. Fischl and Douglas Courtney

Title: Application of a Systems Concept to Personnel Research (Final Report)

Agency: BuPer, USN

Publication Date: August 1958

ABSTRACT:

This report dwells upon "feedback", its history and how useful it would be if employed in the Naval Personnel System. The use of a feedback principle would somehow provide a systems concept.

The research approach, since the idea of applying systems concepts to naval personnel was somewhat revolutionary, was to propose a problem census. (Evidently, the problem census did not come off and the report moves into a single problem solution "what has been the effect of converting petty officers from nonelectronic ratings into ET's.")

The report concludes with a recommendation that eight additional tasks be performed to complete the study.

Comments: Not directly applicable to our project.

Reviewed by: J. C. Powell

Reference 24

Author: Irl A. Irwin and Robert F. Dice

Title: CPRI for C-130 Combat Air Transport System

Agency: ARDC

Publication Date: February 1956

ABSTRACT:

This report presents recommendations to assist action agencies in eliminating minor deficiencies which exist in personnel and training plans for the C-130.

It describes some new duties and increases the quantity of propeller repairmen by 100 per cent above the number programmed. It also changes task requirements so as to smooth out tasks in a too busy AFSC to one which has little to do.

Comments: This is an excellent report. It contains good position information, system description and manning information in concise lucid language.

Reviewed by: J. C. Powell

Reference 25

Author: Robert L. Weislogel and T. Owen Jacobs

Title: A Technique for Displaying Task Analysis Information

Agency: AIR

Publication Date: March 1956

ABSTRACT:

This report illustrates a technique for displaying job requirements of a single operator by use of plastic overlay pages, and a matrix of job activities as a base page.

Comments: A [illegible] tool used in many display efforts.

Reviewed by: J. C. Powell

Reference 26

Author: L. Wiley, H. B. Harber and M. J. Giorgia

Title: Rater Tendencies in Estimating Qualifications Required by Air Force Jobs

Agency: WADC

Publication Date: September 1959

ABSTRACT:

Report of a test which concluded that there was evidence of individual tendencies to use or refrain from using the extremes of the Rating Scale, and that raters have personal tendencies which are consistent over a 4-hour period.

Comments: None

Reviewed by: J. C. Powell

Reference 27

Author: Bernard Voosen

Title: A Method for Estimating Direct Squadron Personnel via Malfunction Rates

Agency: Rand Corporation

Publication Date: April 1958

ABSTRACT:

This research memorandum discusses a method for estimating three types of direct personnel necessary for the Titan missile. The types are operators, maintenance, and repair. The required input information is: an operational concept, its type and complexity, the maintenance concept, a malfunction rate, and repair times. A squadron configuration must also be known or assumed.

Quantitative numbers are developed for the three types of personnel using both a soft base and a hard base and fast or slow reaction.

A comparison of the numbers of personnel estimated under this method with the original OPRI estimate is attempted and a purported saving of manpower is claimed.

Comments: A good try at simplifying a complex problem.

Reviewed by: J.C. Powell

Reference 28

Author: W. Gorham and H. E. Scarf

Title: A Concept of Stability in Manpower Planning

Agency: Rand Corporation

Publication Date:

ABSTRACT:

This paper is an academic exercise which sets forth a mathematical model upon which a stable state of personnel skill level distribution can be achieved.

The assumptions upon which this stability is dependent are many, such as: unless the total force size is changed; unless the enlistment period varies; unless the retention rates vary; etc. The re-enlistment rate is assumed to be constant and many other assumptions are a concept of stability.

Comments: The paper is full of theoretical assumptions which are of little help in solution of real problems.

Reviewed by: J. C. Powell

Reference 29

Author: Glory A. Starsdale

Title: Evaluation of the Qualitative Personnel Requirements Information for Weapon System 115A

Agency: Air Force Flight Test Center.

Publication Date: 5 February 1960

ABSTRACT:

This study was conducted to evaluate the QPRI prepared by Douglas Aircraft Company in these specific areas:

Accuracy and Completeness of Task Information
Validity of Position Requirement Estimates.

Conclusions were that task coverage was adequate, no estimates were included in the QPRI as to amount of time required to perform tasks, the requirement as to "Statements of Hazards Involved" were not met, the "Number and Nature of Positions Needed" portion of the QPRI was not covered in the contractors data.

Eleven recommendations were made with respect to the QPRI format.

Comments: A good constructive critical report.

Reviewed by: J. C. Powell

Reference 30

Author: John D. Folley, Jr., Jean B. Fairman and Edna M. Jones

Title: A Survey of the Literature on Prediction of Air Force Personnel Requirements

Agency: American Institute for Research

Publication Date: July 1960

ABSTRACT:

A survey of methods for predicting personnel requirements for future Air Force weapon systems is presented with abstracts of 121 unclassified, professional documents. Emphasis is placed on identifying procedures for deriving personnel requirements information, and the supporting rationales. The current state-of-the-art is evaluated and presented with implications for future research requirements. Conclusions from the study show that fairly thorough procedures exist for describing tasks and positions and for combining tasks into positions. However, no evidence was found of any systematic evaluation of this method. Estimating manpower requirements often has been done but only one report describes a procedure for doing this. Determining skill level requirements and criticality of tasks has received little methodological attention. Most attention has been directed toward the rating of skill levels rather than toward any objective determination of skill requirements. One exception provides a seven-point scale of operationally defined performance levels. Like the other techniques found in this survey, this one has never been evaluated.

Comments: Invaluable for personnel engaged in Preparing Task Analysis. A thorough professional presentation. Contains 384 pages.

Reviewed by: J. C. Powell

Personnel Subsystems Abbreviation Guide

ACB	Airman Classification Battery
ACO	Administrative Contracting Officer
ACOE	Automatic Checkout Equipment
ADC	Air Defense Command
ADO	Advanced Development Objective
AFCS	Air Force Communications Service
AFLC	Air Force Logistics Command
AFPR	Air Force Plant Representative
AFPTRC	Air Force Personnel and Training Research Center
AFS	Air Force Specialty
AFSC	Air Force Systems Command or Air Force Specialty Code
AGE	Aerospace Ground Equipment
AMC	Air Materiel Command
APP	Airborne Power Plant
AQE	Airman Qualifying Examination
ARDC	Air Research and Development Command
ASC	Aeronautical System C...
ASD	Aeronautical ... of AFSC
ATC	Air Training Command
ATE	Automatic Test Equipment
BMEWS	Ballistic Missile Early Warning System
BOD	Beneficial Occupancy Date
BSD	Ballistic Systems Division of ASC
BTB	Basic Test Battery
CCN	Contract Change Notification
CEM	Contractor Equipment Manuals
CER	Cost Estimating Relationships
CFE	Contractor Furnished Equipment
CFF	Critical Fusion Frequency
CM	Corrective Maintenance
ConAC	Continental Air Command
CPT	Crew Procedures Trainer
CR	Crew Ratio
CTCI	Contract Technical Compliance Inspection
CTL	Combat Training Launch
CTS	Contract Technical Services
DEI	Development Engineering Inspection
DOD	Department of Defense
DS/RPIE	Direct Support Real Property Installed Equipment
ECP	Engineering Change Proposal
EDPC	Electronic Data Processing Center
EET	Equivalent Exposure Time
EMC	Electro Mechanical Checkout
ESC	Electronic Systems Center of AMC
ESD	Electronic Systems Division of AFSC
EWO	Emergency War Order

FTD	Field Training Detachment
GFE	Government Furnished Equipment
GOR	General Operational Requirement
GPO	Government Printing Office
GSE	Ground Support Equipment
HE	Human Engineering
HIAPSD	Handbook of Instructions for Aerospace Personnel Subsystem Designers
HumRRO	Human Resources Research Office (Washington, DC)
I and C	Installation and Checkout
IMT	Individual Military Training
IRAN	Inspection Repair as Necessary
IWST	Initial or Integrated Weapon System Training
JBF	Job Behavior Form
KR	Knowledge of Results
LCC	Launch Control Center
LEET	Limiting Equivalent Exposure Time
LF	Launch Facility
LOAP	List of Applicable Publications
LOM	Launch Operation Manual
MAC	Malfunction Circuitry Trainer
MAF	Manpower Authorization File
MAV	Manpower Authorization Voucher
MGE	Maintenance Ground Equipment
MITM	Military Industrial Technical Manual
MTBF	Mean Time Between Failure
MTD	Mobile Training Detachment
MTU	Mobile Training Unit
NORAD	North American Air Defense Command
OGE	Operating Ground Equipment
OJT	On the Job Training
OPR	Office of Prime Responsibility
ORT	Operational Readiness Training
OSR	Operational Support Requirement
OSTF	Operational Suitability Test Facility
OT	Organization Table
PE	Probable Error
PED	Personnel Equipment Data
PEI	Preliminary Engineering Inspection
PERT	Program Evaluation and Review Technique
PM	Preventive Maintenance
PME	Prime Mission Equipment
PR	Purchase Request, Procurement Request
PSPP	Proposed System Package Plan
PSS	Personnel Subsystem
PSTE	Personnel Subsystem Test and Evaluation

QOR	Qualitative Operational Requirement
QQPRI	Qualitative and Quantitative Personnel Requirements Information
RADC	Rome Air Development Center
RDTandE	Research Development Test and Evaluation
RFP	Request for Proposal
ROC	Required Operational Capability
RPIE	Real Property Installed Equipment
RT	Reaction Time
R/V	Re-entry Vehicle
SAC	Strategic Air Command
SAGE	Semi-Automatic Ground Environment
SAIM	Systems Analysis and Integration Model
SDA	Supporting Data Analysis
SE	Standard Error
SMF	Standard Maintenance Form
SMS	Strategic Missile Site
SOP	Standard Operating Procedure
SOR	Specific Operational Requirement
SPD	System Program Directive
SPO	System Program Office
SPP	System Package Program
SSB	Source Selection Board
SSD	Space Systems Division of AFSC
SSSB	System Source Selection Board
STEP	System Training and Exercising Program
SYSTO	System Staff Office
TA	Task Analysis
TAC	Tactical Air Command
TC	Training Concept
TD	Table of Distribution
TEA	Task Equipment Analysis
TED	Training Equipment Development
TEL	Training Equipment List
TEPI	Training Equipment Planning Information
TePu	Technical Publications
TERG	Training Equipment Requirement Guide
TM	Technical Manual
TO	Technical Order
T/O	Table of Organization
TOCU	Technical Order Coordination Unit
TOTC	Time Compliance Technical Order
TP	Training Plan
TPL	Training Parts List
TPR	Trained Personnel Requirements
TR	Training Requirement
UAL	Unit Authorization List
UE	Unit Equipment
UMD	Unit Manning Document
UME	Unit Manning Equipment
UPS	Unit Personnel System
USAPRO	US Army Personnel Research Office
USNTDC	US Navy Training Device Center (Port Washington, NY)
WS	Weapon System
WSPO	Weapon System Project Office

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Aerospace Corporation, El Segundo, California
THE COMPARATIVE VALIDITY OF MANPOWER PREDICTION TECHNIQUES, 24 June 1963
pages including illustrations. (Report TDR [illegible] 1741-08)TN-1, BSD-TDR-63-129 (Contract No. AF04(694)-169.

Unclassified Report

This report presents the results of a research effort within the personnel subsystems area conducted to ascertain the validity of various man-power prediction techniques. The report consists of a literature survey including bibliography, findings and conclusions, a state-of-the-art summary based on the literature survey, and plans and recommendations for future research in the specific area of manpower prediction.

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