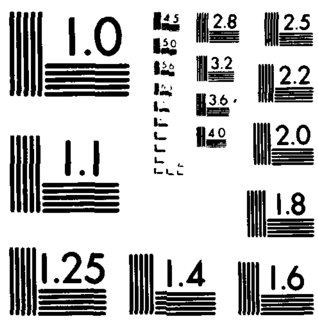
AD-A089 707 DYNAMICS RESEARCH CORP WILMINGTON MASS F/G 15/5
AIR FORCE PERSONNEL AVAILABILITY ANALYSIS: A DESCRIPTION OF THE--ETC(U)
SEP 80 J C GOCLOWSKI, A J LOFASO, S E PESKOE F33615-77-C-0032
UNCLASSIFIED AFHRL-TR-79-66 NL

1 of 2
AD
A089707

END
FILMED
11-80
DTIC

CONT.


1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0

LEVEL II

AFHRL-TR-79-66

AIR FORCE HUMAN RESOURCES LABORATORY

AD A089707

AIR FORCE PERSONNEL AVAILABILITY ANALYSIS: A DESCRIPTION OF THE PERSONNEL AVAILABILITY MODEL (PAM)

By

John C. Goclowski
Anthony J. LoFaso
Stuart E. Peskoe
Dynamics Research Corporation
60 Concord Street
Wilmington, Massachusetts

H. Anthony Baran

LOGISTICS AND TECHNICAL TRAINING DIVISION
Wright-Patterson Air Force Base, Ohio 45433

DTIC ELECTE SEP 1980 S

September 1980

Final Report

Approved for public release; distribution unlimited.

DDC FILE COPY

AIR FORCE SYSTEMS COMMAND
BROOKS AIR FORCE BASE, TEXAS 78235

80 9 30 035

NOTICE

When U.S. Government drawings, specifications, or other data are used for any purpose other than a definitely related Government procurement operation, the Government thereby incurs no responsibility nor any obligation whatsoever, and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data is not to be regarded by implication or otherwise, as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

This final report was submitted by Dynamics Research Corporation, 60 Concord Street, Wilmington, Massachusetts 01887, under Contract F33615-77-C-0032, Project 1959, with the Logistics and Technical Training Division, Air Force Human Resources Laboratory (AFSC), Wright-Patterson Air Force Base, Ohio 45433. Mr. H. Anthony Baran was the Contract Manager for the Laboratory.

This report has been reviewed by the Office of Public Affairs (PA) and is releasable to the National Technical Information Service (NTIS). At NTIS, it will be available to the general public, including foreign nations.

This technical report has been reviewed and is approved for publication.

ROSS L. MORGAN, Technical Director
Logistics and Technical Training Division

RONALD W. TERRY, Colonel, USAF
Commander

SUBJECT TO EXPORT CONTROL LAWS

This document contains information for manufacturing or using munitions of war. Export of the information contained herein, or release to foreign nationals within the United States, without first obtaining an export license, is a violation of the International Traffic in Arms Regulations. Such violation is subject to a penalty of up to 2 years imprisonment and a fine of $100,000 under 22 U.S.C. 2778.

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER AFHRL-TR-79-66	2. GOVT ACCESSION NO. AD-A089 707	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) AIR FORCE PERSONNEL AVAILABILITY ANALYSIS: A DESCRIPTION OF THE PERSONNEL AVAILABILITY MODEL (PAM)		5. TYPE OF REPORT & PERIOD COVERED Final
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) John C. Goclowski, H. Anthony Baran, Anthony J. LoFaso, Stuart E. Peskoe		8. CONTRACT OR GRANT NUMBER(s) F33615-77-C-0032
9. PERFORMING ORGANIZATION NAME AND ADDRESS Dynamics Research Corporation 60 Concord Street Wilmington, Massachusetts 01887		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 63751F 19590003
11. CONTROLLING OFFICE NAME AND ADDRESS HQ Air Force Human Resources Laboratory (AFSC) Brooks Air Force Base, Texas 78235		12. REPORT DATE September 1980
		13. NUMBER OF PAGES 56
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) Logistics and Technical Training Division Air Force Human Resources Laboratory Wright-Patterson Air Force Base, Ohio 45433		15. SECURITY CLASS. (of this report) Unclassified
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

human resource availability
human resource requirements
maintenance personnel
Markov model
personnel availability model
personnel availability
system support personnel
weapon system maintenance

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This is the first of three technical reports describing a methodology for projecting the future availability of Air Force personnel and analyzing the potential impacts of personnel policy changes. Developed within the Air Force Human Resources Laboratory's Project 1959, "Advanced System for the Human Resources Support of Weapon System Development," the methodology will provide the Air Force with an increased capability for considering the human resources requirements of weapon systems in terms of the future availability of personnel needed to maintain and operate the systems, and the factors which determine personnel availability.

DD FORM 1 JAN 73 1473

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

318102

Item 20 Continued:

The report documents the development of a key element of that methodology—a computerized Personnel Availability Model (PAM) and its associated data bank. Report AFHRL-TR-79-67 describes application techniques, and report AFHRL-TR-79-68 provides a program description which includes an applied PAM analysis of Air Force personnel.

The PAM represents career transition activity within the Air Force by a series of Markov processes, each depicting a subpopulation of airmen with states defined by year of service and paygrade. State transition probabilities are calculated on the basis of actual transition activity data contained in the Uniform Airman Record (UAR). Subpopulations may be defined on an a priori basis such as by Air Force Specialty Code (AFSC) designation, or analytically established by applying a discrete dependent variable regression analysis technique called Logit Analysis. This technique, described in technical report AFHRL-TR-79-67, identifies subpopulations of personnel with similar career transition behavior and describes them in terms of individual attribute data contained in the UAR.

Basically, the PAM operates on UAR data to project future career transition activity on the basis of occurrences in the past. The results are processed to yield "snapshot" descriptions of the total force composition at user selected intervals. The PAM data bank presently contains a selection of data elements from the 1975 and 1976 UAR files for approximately 95,000 airmen assigned to 13 AFSCs.

SUMMARY

BACKGROUND

Future weapon systems should be developed with consideration of the personnel requirements associated with system operation and support, and of the future military personnel availability needed to fulfill those requirements. Thus, there is a definite need for a personnel availability model which includes techniques capable of (1) estimating the future availability of military personnel, (2) identifying possible difficulties in meeting future weapon system personnel requirements, and (3) examining corrective actions to avoid, or at least reduce, the possibility of critical personnel shortages which might diminish Air Force operational capability in the future.

A methodology for personnel availability analysis was developed to at least partially satisfy the needs listed above. The Personnel Availability Model (PAM) evolved from this methodology. The PAM projects the future availability of Air Force (AF) personnel based on historical data contained in the 1975 and 1976 Uniform Airman Record (UAR) files for approximately 95,000 airmen assigned to 13 Air Force Specialty Codes (AFSCs).

APPROACH

Prior to the model development effort, relevant characteristics and capabilities of the AF Personnel System were evaluated to identify a model which would meet AF requirements. This set of charactaeristics and capabilities then was used as a screening device in the search for existing models which could be used directly or modified for the analysis of AF personnel availability. Models identified as potential candidates were subjected to a detailed examination to further define their potential, particularly in terms of their capability for selectively projecting the future availability of specific groups of personnel (such as groups identified on the basis of readily distinguishable attributes). Based on the results, it was decided that the development of a new model was necessary and desirable to provide the flexibility and precision required to make the model a useful tool in weapon system development. It was also decided that the UAR was the most suitable vehicle of stable data collection on which to base both the model and its data bank. The model and data bank were supplemented by several statistical techniques which can be used to increase the accuracy of output products and to broaden the range of circumstances under which they can be used. Then a methodology was developed for personnel availability analysis. It was demonstrated in a test application which addressed 13 AFSCs.

RESULTS

Results of the PAM effort include the development of a methodology, application techniques, a computer program, and a sample data base. The PAM provides a capability to project the future availability of Air Force personnel and the potential impacts of changes in personnel policy, and to readily compare projected personnel requirements to projections of AF personnel availability.

PREFACE

This is the first of three technical reports describing a personnel availability model, its related application methodology, and a sample application. The Personnel Availability Model has been designed for use in projecting and analyzing the future availability of Air Force personnel. Work was performed under USAF Contract No. F33615-77-C-0032.

This report describes the development and functions of the model and its data bank. Report AFHRL-TR-79-67 provides application techniques and report AFHRL-TR-79-68 contains a program description involving an applied PAM analysis of Air Force personnel.

Work was directed by the Logistics and Technical Training Division, Air Force Human Resources Laboratory, Wright-Patterson Air Force Base, Ohio. It is documented under Work Unit 19590003 of AFHRL Project 1959, "Advanced System for Human Resources Support of Weapon Systems Development." Dr. William B. Askren was the Project Scientist. Mr. H. Anthony Baran was the Work Unit Scientist and Air Force Contract Manager. Mr. John Goclowski was the Contractor Program Manager.

Work Unit 19590003, "Air Force Maintenance Personnel Availability Analysis," was undertaken to provide the Air Force with improved tools and techniques for anticipating the future impact on its personnel force structure resulting from the human resource requirements of new weapon systems.

Appreciation is extended to Dr. Gordon A. Eckstrand and Dr. Ross L. Morgan of the Logistics and Technical Training Division for their guidance in constructing the modeling system described in this report and to Dr. Robert A. Bottenberg, Director, Analysis and Evaluation Office of the Air Force Human Resources Laboratory for his help in obtaining the personnel data essential to its operation.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

AIR FORCE PERSONNEL AVAILABILITY ANALYSIS
A DESCRIPTION OF THE PERSONNEL AVAILABILITY MODEL (PAM)

INTRODUCTION

Human resources (HR) requirements stem from engineering and equipment considerations as well as operational plans developed during the weapon system design process. In the past, the specifics of future HR requirements have been given only cursory consideration during weapon system design. The detailed considerations were generally reserved until the later stages of weapon system production and deployment. This approach was accepted due to the general availability and low costs associated with obtaining required HR, and due to the lack of techniques necessary to predict the HR requirements.

However, this enviable low cost/high supply situation has ceased to exist. Increasing personnel costs and lower budgetary ceilings have a negative impact on the continued availability of HR. In addition, the effects of these cost factors are compounded by policy decisions which affect recruitment rates, re-enlistment rates, skill levels, and career fields.

As the cost and scarcity of existing HR have increased, future requirements have become a more important consideration during weapon system design. This growing importance is justified because the ability to meet these requirements will inevitably determine the capability of the Air Force (AF) to effectively operate and maintain future weapon systems. Inadequate or untimely considerations of HR requirements can substantially diminish the operational and support capabilities and the cost effectiveness of the weapon system.

The growing importance of HR cost and availability prompts a demand for a new analytic technique. Such a technique is needed to determine how HR may be best employed to meet future weapon system requirements. Of particular concern is the availability of personnel now and in the future. To meet HR requirements, the technique must be capable of projecting current HR availability into the future. Application of such a technique will permit planners to forecast, and thus resolve possible conflicts between HR requirements and HR availability.

The effort reported here was undertaken to develop a model which would project (and thus assist in controlling) HR availability. Further, the effort was designed to provide a data bank reflecting both past and present HR availability, and an interactive method by which projected output may be adjusted or corrected based upon personnel policy changes.

This report outlines the process by which the model and its related products were developed. In addition, it provides a description of the model and related products.

OBJECTIVE

The objective of this effort is to provide a means of predicting the composition and strength of the United States Air Force (USAF) manpower structure in future time frames such that weapon system support personnel requirements can be assessed more fully in terms of the future availability of HR to meet these requirements.

THE PAM DEVELOPMENT - THE TECHNICAL APPROACH

The five-phase technical approach was developed to efficiently achieve the objective of this effort.

PHASE 1 State the desired characteristics of a personnel availability model.
PHASE 2 Conduct a search for existing personnel models which contain one or more of the desired characteristics of the model.
PHASE 3 Select/adapt an existing personnel model which possesses the desired characteristics of the model; or, if no such model exists, construct a unique model which does.
PHASE 4 Define and develop a data base for use with the model.
PHASE 5 Describe and demonstrate the operation of the model.

Figure 1 depicts the technical approach used in this effort.

The following sections of this report describe each phase of the technical approach and indicate the specific activities conducted within each phase.

PHASE 1 - STATE THE DESIRED CHARACTERISTICS OF A PERSONNEL AVAILABILITY MODEL

A useful model for personnel availability projection must be part of an organized approach to personnel availability. Figure 2 depicts such an approach and suggests how a personnel availability model functions as part of the entire approach. In this capacity, it is apparent that a personnel availability model should serve three sequential functions to:

1. Indicate existing HR availability.
2. Project HR availability in the future.
3. Present projected HR availability in a format allowing effective and expeditious comparisons with future requirements.

The first phase of the model development effort involved the determination of characteristics necessary for a model to accomplish the functions stated above. Defining these characteristics was imperative to evaluate existing personnel/manpower models, and to construct a new model in the event that a suitable existing one could not be found. The desired characteristics of a personnel availability model are as follows.

1. The ability to use existing personnel data, especially for technical personnel. It was believed that the ability to use existing personnel data, such as those contained in the Uniform Airman Record (UAR), would facilitate the use of the model.

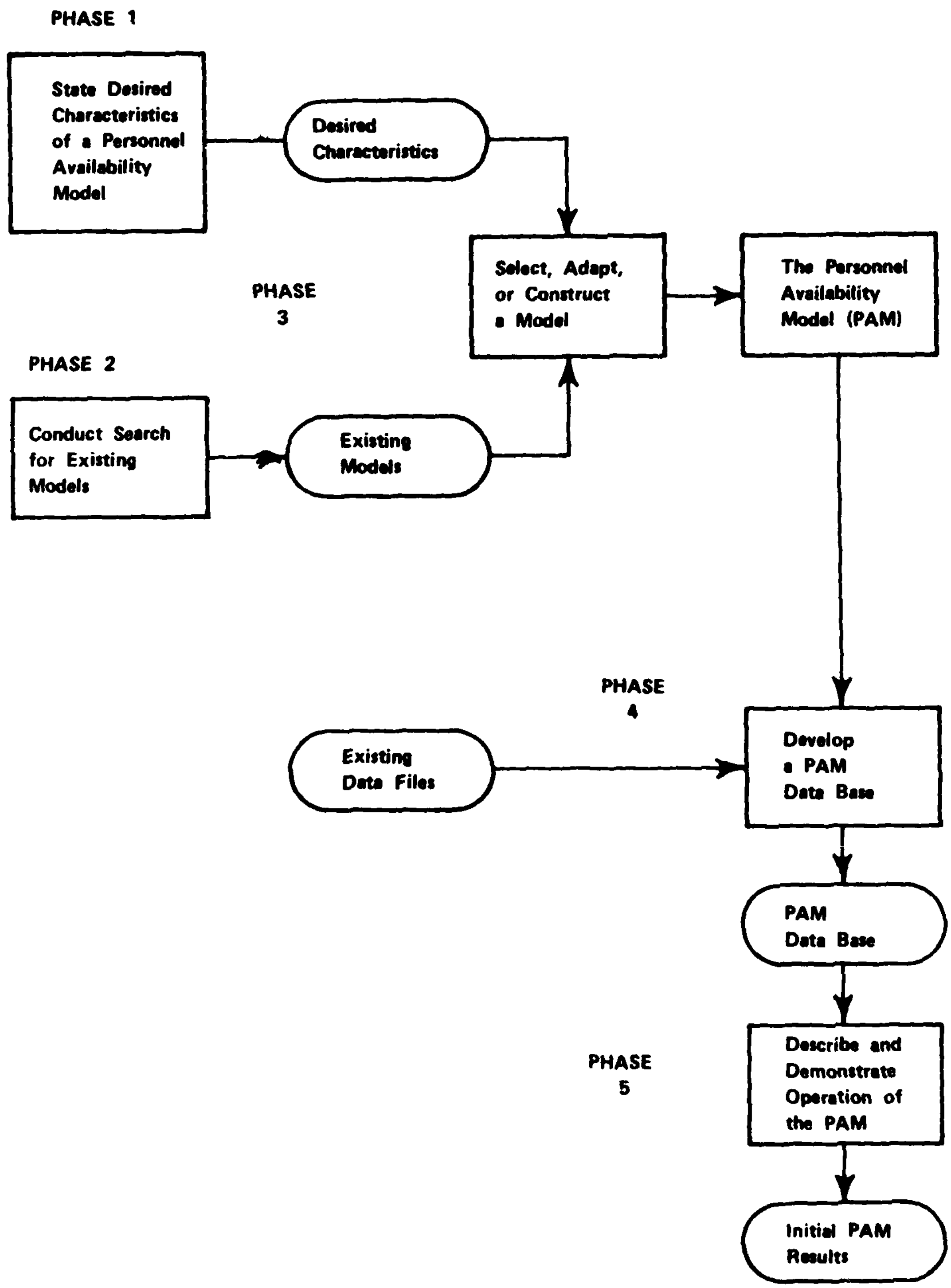


Figure 1 – The PAM development
The technical approach.

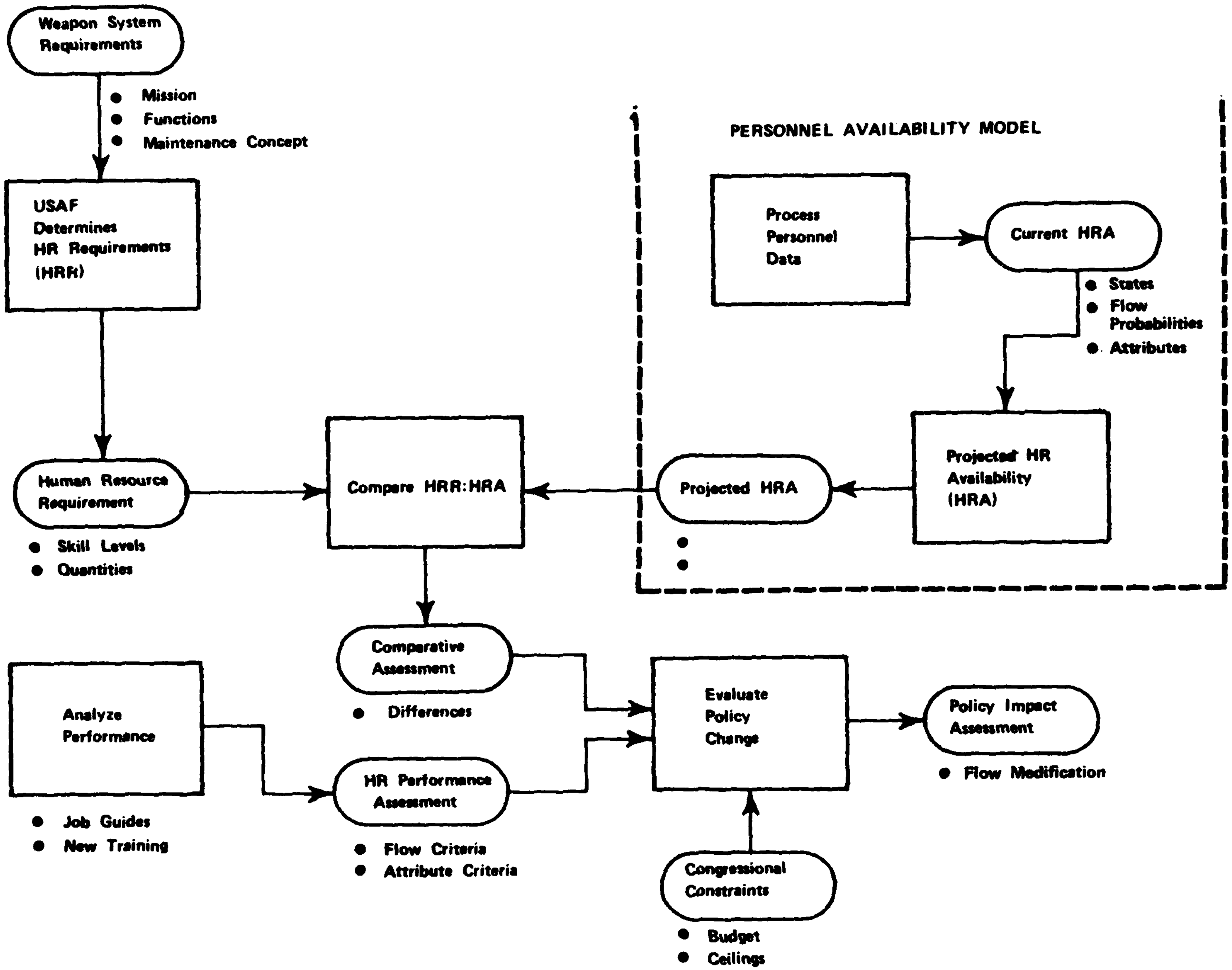


Figure 2 — Technical approach to

2. The ability to describe current HR status within the USAF in terms most relevant to AF interests (for example, in terms of the quantity of personnel within a job category by years of service, paygrade, and/or other relevant personnel attributes).

3. The ability to track and project changes in HR status within the USAF. This would permit the prediction of future HR availability based on recorded career behavior patterns, the manpower system, and the current or postulated personnel policy. In addition, it would allow the probable flow of airmen between states of the USAF manpower system to be described, permitting the analysis of career transition activity over time.

4. The ability to predict future availability for subpopulations defined by a set of user-specified personnel attributes. This would permit projections to be made, not only for gross categories of personnel, but also for members of subcategories which could be defined in terms of specific attributes (for example, age, aptitude test scores, number of dependents, and/or years on location.)

5. The ability to evaluate the probable effects of personnel policy changes on future HR availability. This would permit the model to define the potential impact on future HR availability of predicted changes in AF personnel policies (for example, policy changes in training, recruitment, transfer, upgrading, and retention).

6. The ability to generate future HR availability data in formats which permit a ready comparison with estimates of future HR requirements data.

PHASE 2 - CONDUCT A SEARCH FOR EXISTING MODELS

During the course of the model search, a total of 33 manpower/personnel models were reviewed (see Appendix A for a listing of the models). Although some of the models were not directly related to the required functions of a personnel availability model, they were examined as a source of ideas regarding the possible modification of more pertinent existing models or the design of a new model. To aid in the evaluation (PHASE 3), the models obtained were grouped in six categories (I to VI).

I Manpower Requirements Models - These models output total force strengths and skill mixes for the purpose of planning organizational functions. They are designed to look at total force strength numbers, varying only in personnel grade and year of service.

II Active Inventory Models - These models describe the personnel inventory currently in the system. They are capable of handling changes resulting from modified manpower requirements.

III Inventory Projection Models - These models estimate future personnel based solely on extrapolations of the current inventory.

IV Requirements/Inventory Analysis and Projection Models - These models compare the predicted human resource requirements with human resource availability.

V Policy Generator Models - These models investigate the impact of changes in policy on requirement/inventory mismatches.

VI Productivity Measurement Models - These models measure the impact of a weapon system operating environment on the productivity of the individual required to operate or maintain that system.

PHASE 3 - SELECT, ADAPT, OR CONSTRUCT A MODEL MEETING THE DESIRED CHARACTERISTICS

Existing Model Investigation

None of the models reviewed during Phase 2 of this effort were considered acceptable for selection as, or adaptation to, a personnel availability model. This decision was made because all of the models which were reviewed lacked a number of the characteristics essential to this specific effort. General comments on the models reviewed were as follows.

1. Although some model would provide a direct link between HR requirements and availability, none of the reviewed models involved a requirements/inventory analysis.

2. None of the models reviewed was capable of selecting particular subpopulations (identified by specific personnel attributes) and projecting the availability of those subpopulations into future time frames.

3. Active inventory models and inventory projection models initially seemed to be consistent with many of the desired characteristics of the required model. However, the examples of both model types reviewed were designed to address large populations with only a limited capability for the analysis of subpopulations. Paygrade and years of service were found to be only personnel attributes which could be used to identify a population as it transitioned through the personnel system. Further, the operation of these inventory projection models produced results which were deemed too coarse.

Unique Model Construction of the Personnel Availability Model

Results of the search for existing models suitable to the needs of this study indicated that to fulfill AF requirements for a mechanism to project personnel availability, the construction of a new model was necessary. Figure 3 describes the model which was designed.

The constructed PAM involves a series of mathematical computations, based upon present and past personnel availability, to project future HR availability. This projection is based on the transition of personnel (for example, from some number of years service and paygrade to some other number of years service and paygrade).

The following aspects of personnel career transition process would be tractably modeled as a finite state, discrete time Markov process*.

1. It is hierarchical when states are defined by year of service (YOS) and paygrade. Ignoring demotions, which are sufficiently infrequent, airmen can only move from low paygrades and low years of service to higher paygrades and higher years of service if they are to remain in the system.

2. It is finite. The state (YOS, paygrade) of an airman at time t+1 depends primarily on the state at time t and less so on the state at prior times.

3. It is discrete. Airmen transitions are measured at yearly intervals rather than at random times.

In addition to the structural suitability of the Markov model to take advantage of the above three properties of the AF Manpower System, it is computationally easy to use. Hence, the Markov model provides the added benefit of providing an efficient capability for testing the impact on future personnel availability of hypothesized AF personnel policy decisions.

The mechanics of the Markov model used for the PAM are simple. A personnel inventory (population) possessing specified attributes is partitioned into a state matrix with states defined by YOS and paygrade. Once the state matrix for a given population is defined, the probability of a transition is computed from historical data. Figure 4 provides an example of a typical state matrix.

---

*The basic Markov assumption states that if a subject is in state i at a given time, the probability of moving to state j in the next time period is independent of how the subject arrived at state i.

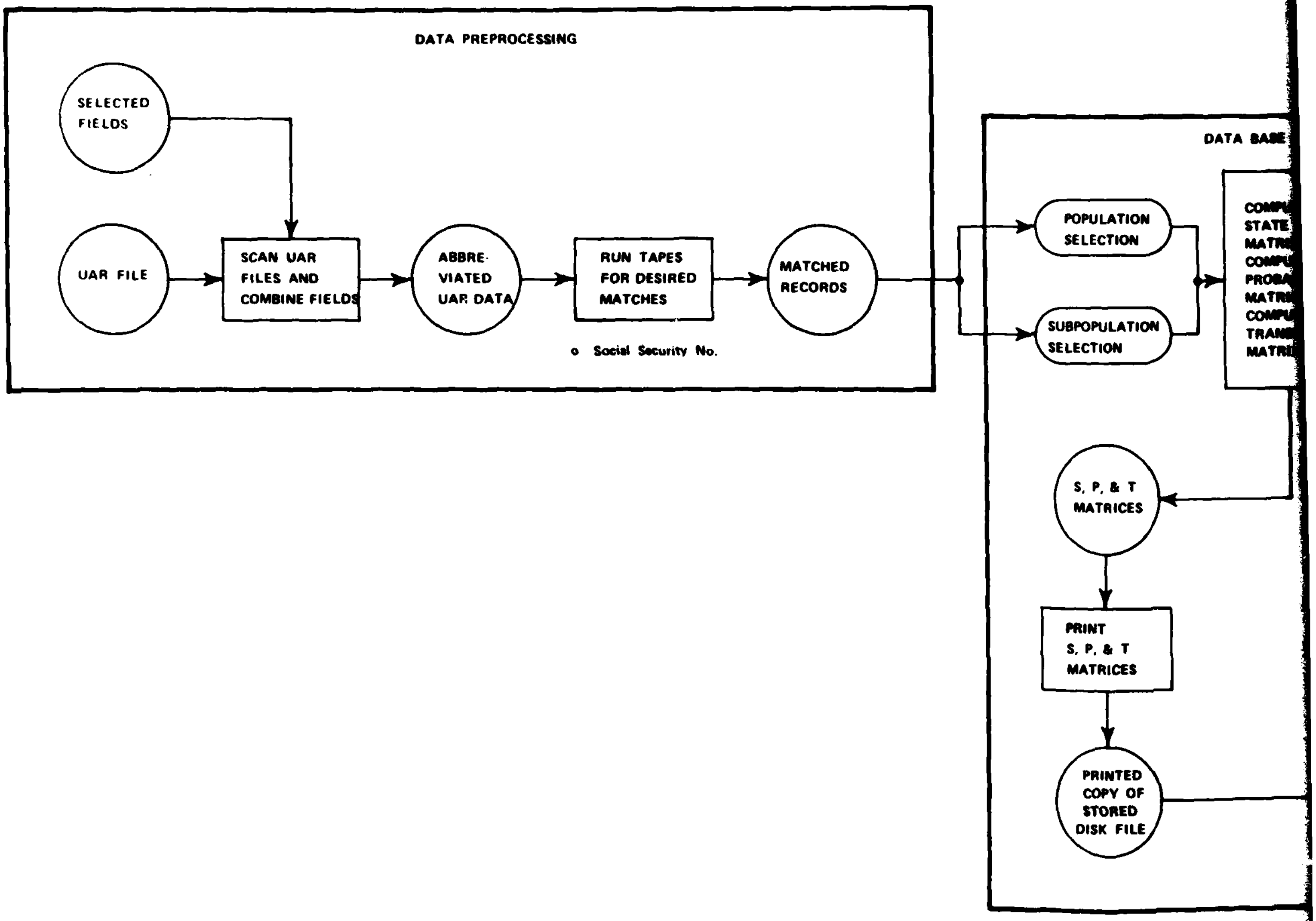
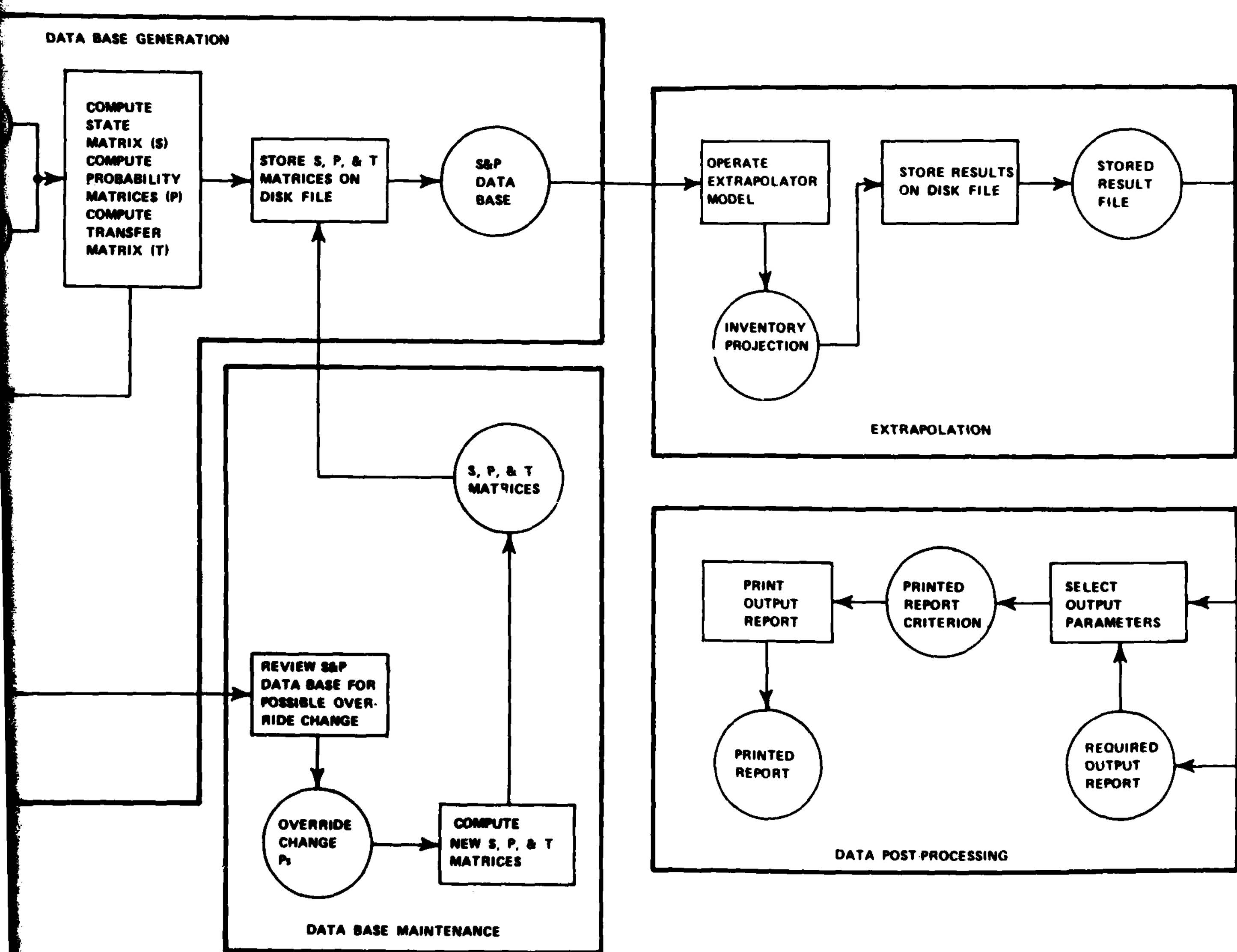


Figure 3 - PAM flow diagram.


DATA BASE GENERATION
COMPUTE STATE MATRIX (S) COMPUTE PROBABILITY MATRICES (P) COMPUTE TRANSFER MATRIX (T)
STORE S, P, & T MATRICES ON DISK FILE
S&P DATA BASE
OPERATE EXTRAPOLATOR MODEL
STORE RESULTS ON DISK FILE
STORED RESULT FILE
INVENTORY PROJECTION
EXTRAPOLATION
S, P, & T MATRICES
REVIEW S&P DATA BASE FOR POSSIBLE OVER-RIDE CHANGE
OVERRIDE CHANGE Ps
COMPUTE NEW S, P, & T MATRICES
DATA BASE MAINTENANCE
PRINT OUTPUT REPORT
PRINTED REPORT CRITERION
SELECT OUTPUT PARAMETERS
PRINTED REPORT
REQUIRED OUTPUT REPORT
DATA POST-PROCESSING

STATE MATRIX

FOR AFSC 431X1E*

Paygrade	YEARS OF SERVICE 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
7	0	0	0	0	0	0	0	0	0	0	1	1	6	11	31	74	49	57	91	130	445
6	0	0	0	0	0	0	0	1	14	57	112	76	132	196	253	351	186	160	129	174	374
5	0	0	0	0	27	110	293	385	452	717	540	184	100	107	108	63	25	23	16	15	15
4	0	1	77	771	1260	797	581	197	110	42	19	4	1	2	0	1	0	0	0	0	1
3	934	1147	3102	1665	54	25	34	10	1	5	2	0	0	0	0	0	0	0	1	0	1

*1975 Record

Figure 4 - Example of a state matrix.

The model examines the change in that state population over a one year period and calculates the transition probabilities of upgrade, increment (in YOS without change in paygrade), loss from service, and transfer. Transition matrices for upgrade, increment, loss from service, and transfer are stored in a state and probability data base. With this data base, future state populations can be determined by considering the following dynamics. Transition into a state occurs in one of three ways.

1. A transfer from some other AFSC or a new accession into the system.

2. An increase in paygrade with an incremental increase in YOS.

3. An incremental increase in YOS without a change in paygrade.

The following equation defines the computation for determining a new state value for each succeeding year. Note that because the year of service is monotonic, the i subscript carries time in the equation for the new state. The new state value is determined by the transitions from the previous state.

$$S'_{ij} = (S_{i-1,j})(PI_{i-1,j}) + (S_{i-1,j-1})(PU_{i-1,j-1}) + T_{ij}$$

where:

S_{ij} is the population of the state with year of service (i) and paygrade (j).

S'_{ij} is the population of the ij state that is projected one year ahead.

$PI_{i-1,j}$ is the probability that airmen in the i-1,j state will increment their year of service (i) by one year, but will remain in the same paygrade (j).

$PU_{i-1,j-1}$ is the probability that airmen in the i-1,j-1 state will upgrade to the next higher paygrade, in addition to incrementing their year of service by one year.

T_{ij} is the probable difference between number of airmen that will transfer into the ij state from outside the AFSC population and those in the ij state that will transfer out of the population each year.

A typical state in the model is illustrated in Figure 5. The solid arrows indicate the transitions that produce a new state population S'_{ij}. Segmented arrows indicate how personnel leave any typical state.

If the transition probabilities were known precisely and remained constant over time, the HR availability could be computed as a function of time. In reality, the transition probabilities are only approximately constant. Consequently, accuracy decreases as a function of the forecasting time. This factor should be taken into account by users of

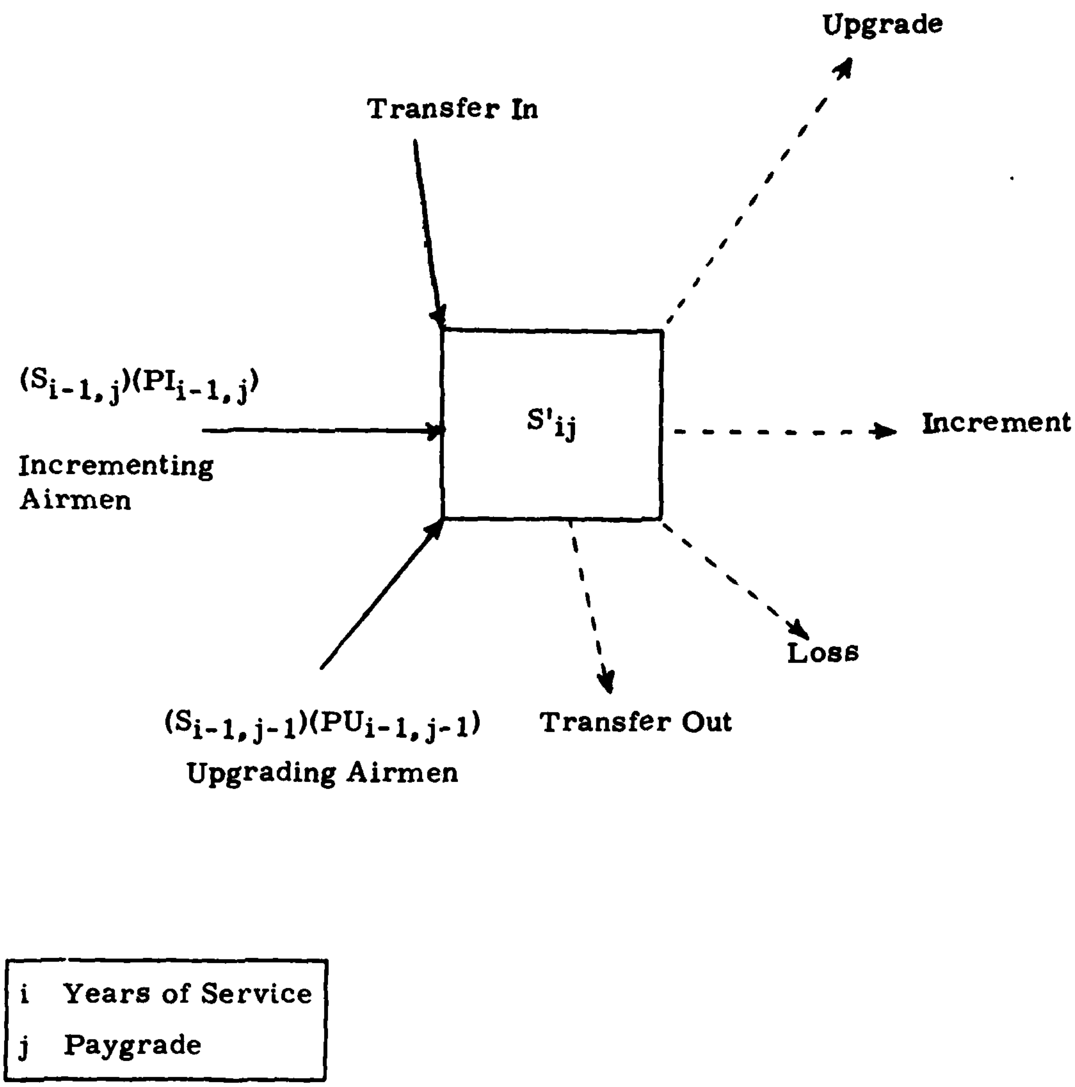


Figure 5 - Typical state.

the PAM when making long-term projections. The PAM operation requires that the initial state transfer probabilities be held constant for each state transfer within the series which comprises a personnel availability projection. The assumption that this constancy will reflect real world circumstances and their combined effect on AF personnel career progression becomes less tenable as the period of projection becomes larger. In summary, some loss of accuracy must be expected as a result of the length of projection over time.

The PAM provides a capability to modify any of the state transfer probabilities. Thus, if there is a need to examine the effects of transition probability changes, the user can adjust the probabilities to reflect personnel policy changes. For example, a user who wants to test a hypothesis pertaining to the impact of policy changes occurring at any intermediate year in the projected time span can do so with the PAM. This is an important feature of the PAM because it allows the investigator to adapt the model to reflect anticipated changes in the flow of personnel (policy changes, environmental factors, etc.) and thus identify problems in the personnel flow that may require action in the policy arena.

The PAM also may be used as a tool for investigating force levels of specifically defined populations of AF personnel, for example, a specific career field. Specific populations are selected for study and defined on the basis of their associated attributes. The relevant attributes are read from a file that contains information from the UAR. The probabilities of upgrade, increment, and loss for each state are computed based on the population transitions recorded in whatever base UAR file is considered representative for the purpose at hand. (Note that the 1975-1976 UAR file provided the base source data used throughout the PAM development.) That population is then projected in a year-by-year stepping process to a user-specified future data.

The establishment of the HR availability projection is completed with a computer printout of the projected population depicting quantities of personnel by YOS and paygrade. The flow diagram presented in Figure 6 illustrates the entire process of the HR availability projection using the PAM.

In addition, if the probabilities calculated by the model for the selected population are unacceptable to the user, the user can exercise an override feature that is built into the model. This override capability allows the performance of edit and check functions, enabling the user to modify any state, transfer-in, or probability matrix on an element-by-element basis.

In summary, the PAM permits a user to make the desired projections based solely on historical data or make the desired projections based on historical data modified to reflect known or expected changes in the AF Personnel Policy.

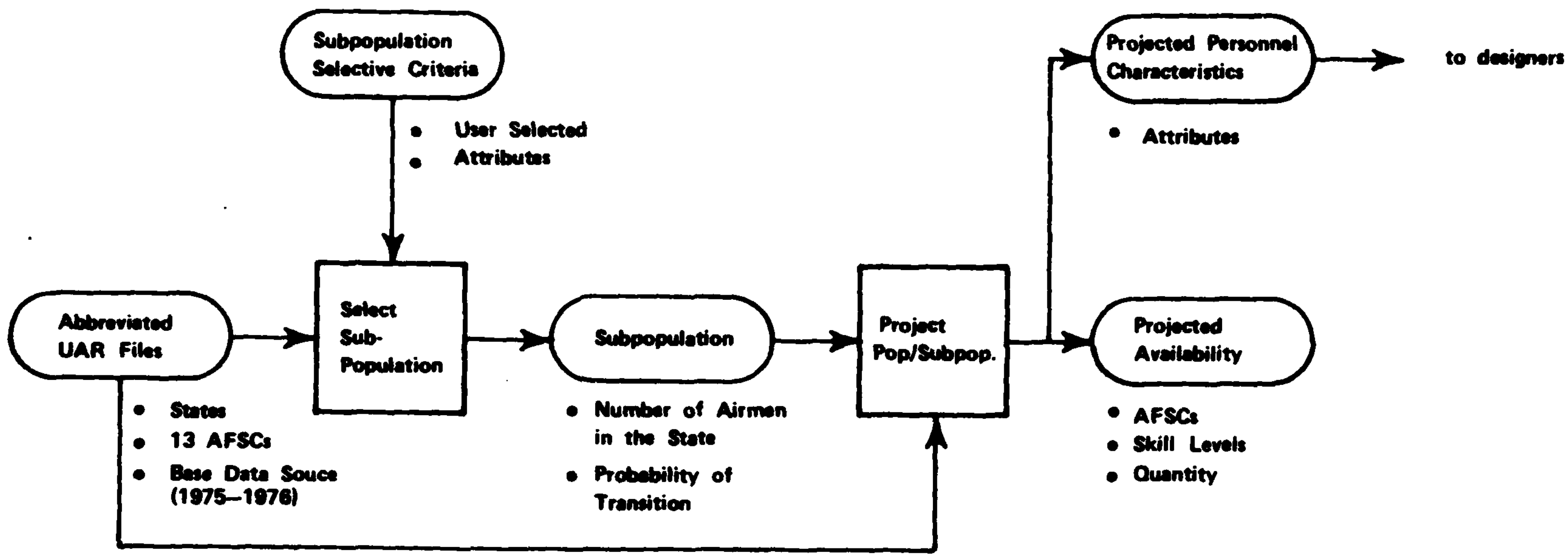


Figure 6 – Establishment of human resource availability.

PHASE 4 - DEFINE AND DEVELOP A DATA BASE FOR THE PAM

The UAR was chosen as the best source of data to use in a personnel availability model. For purposes of this effort, 1975 and 1976 UAR data for personnel within 13 maintenance AFSCs (see Table 1) were obtained. This data set is briefly described in Appendix B.

Even though the data set was limited to only 13 AFSCs, it was still too voluminous for direct use in the PAM. Each individual UAR is comprised of over 450 identifiable personnel attributes for approximately 95,000 airmen in the years 1975 and 1976. After the initial examination of the UARs, an abbreviated subset of the available attributes was selected to meet the needs of this effort. The basic PAM, however, could be reprogrammed to operate on the total data source using any one or more of the 450 personnel attributes available in the UAR.

To make this subset selection, the available attributes were examined to identify those which were related to or might be determinants of personnel career transitions. Twenty-four potentially significant attributes (see Table 2) were selected for inclusion in the PAM data base. Data regarding those attributes were then extracted from the UAR to form an abbreviated UAR file (see Figure 7) for use by the PAM.

The two resulting abbreviated UAR files for the years 1975 and 1976 were then combined to form a single data file. Based on this data, it is possible to determine whether each airman incremented in YOS without a paygrade change was promoted with an increase in pay, transferred, or left the service from 1975 to 1976. The specific transitions occurring between 1975 and 1976 were then recorded in a combined file of each airman.

Using the 1975 and 1976 transition data, transition probabilities were computed in terms of the state (S) matrix and probabilities (P) matrices.

Computation of state (S) matrix
S_{ij} = number of airmen in the population during year with YOS (i) and paygrade (j)

Computation of probability (P) matrices
$PU_{ij} = \dfrac{\text{number of airmen who left state (i,j) from 1975-1976 by promotion}}{S_{ij} = \text{population of state (i,j) in 1975}}$
$PI_{ij} = \dfrac{\text{number of airmen whose grade remained same for 1975-1976}}{S_{ij} = \text{population of state (i,j) in 1975}}$

Table 1 - Representative Air Force Specialty Codes.

AFSC	SPECIALTY CODES
325x0	Automatic Flight Control Systems
325x1	Instrument Systems
328x0	Avionic Communications
328x1	Avionic Navigation Systems
328x4	Inertial and Radar Navigation Systems
423x0	Aircraft Electrical Systems
423x1	Environmental Systems
423x3	Fuel Systems
423x4	Pneudraulic System
426x2	Jet Engines
431x1C	Aircraft Maintenance (Jet, over 2 engines)
431x1E	Aircraft Maintenance (Jet, 1 and 2 engines)
531x3	Airframe Repair

Table 2 - Personnel Attributes Selected for Use in the PAM Data Base

Proficiency Pay	General Test Score (%)
Hazardous Duty Status	Mechanical Test Score (%)
Primary AFSC	AFQT Score
Secondary AFSC	Paygrade
Control AFSC	USAF Supervisory Exam Results
Duty AFSC	Total Active Military Service
Education Attained	Race
Year Graduated	Sex
Training Status	Birth Date
Training Date	Marital Status
Administrative Test Score (%)	Number of Dependents
Electronics Test Score (%)	Special Experience Identifier

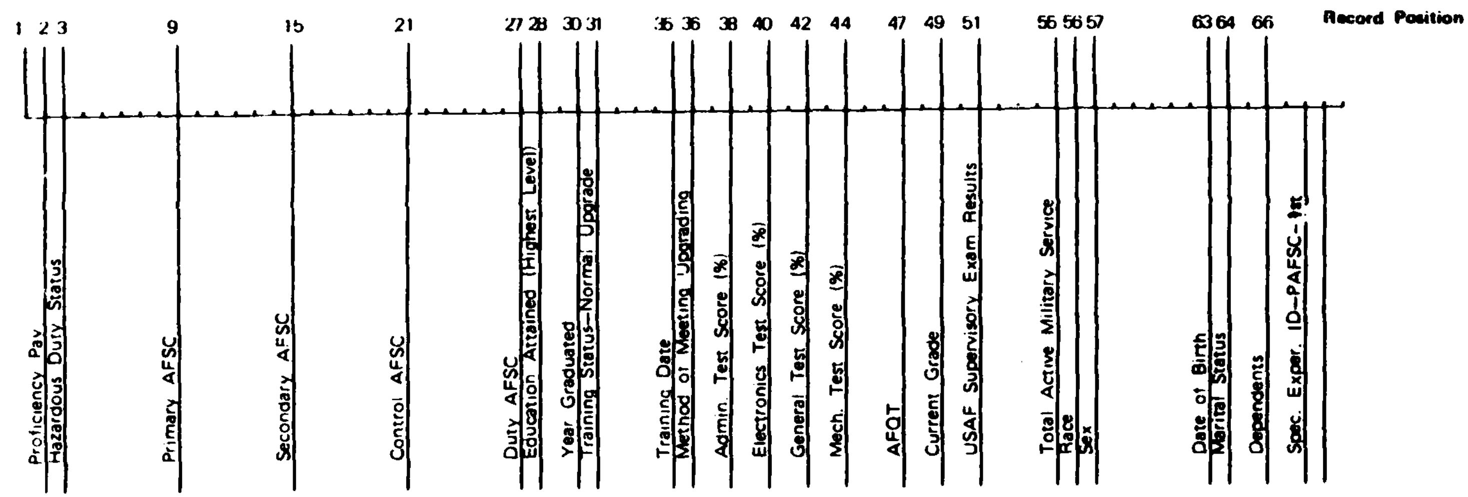


Figure 7 — Abbreviated UAR file.

The four types of specialty codes contained in an abbreviated UAR are as follows:

1. Primary (PAFSC) - that in which the individual is most highly qualified to perform duty.

2. Secondary (2AFSC) - represents the second best additional qualification.

3. Control (CAFSC) - highest awarded AFSC in the ladder in which airman is being utilized or trained.

4. Duty (DAFSC) - identical to the authorized manning document position to which airman is officially assigned.

Normally, the PAFSC and DAFSC are identical in an airman's UAR, since assignments are kept consistent with capabilities. In some cases (overseas assignment, crosstraining, etc.), the DAFSC is the same as the 2AFSC. The PAM logic shown in Figure 8 checks for this exception prior to taking the AFSC as being equal to the PAFSC.

The analyst can select any AFSC (3-digit, 5-digit, with or without skill level, etc.) to evaluate in terms of population size, transition rates, or attributes. After selecting records in the UAR which contain the particular AFSC to be evaluated, the PAM logic then proceeds to identify those airmen who were in the AFSC population during all of 1975, as well as all of the transfers in and out of the population. An airman who had the same AFSC, both at the end of 1975 and at the end of 1976, is considered to have been in that AFSC population during all of 1976. If the airman had that AFSC in 1975, but not in 1976, the airman is given a transfer-out status.

Having the AFSC in 1976, but not in 1975, indicates a transfer into the population. A transfer-in occurs through either recruitment or transfer from some other AFSC population. A transfer-in due to recruitment was assumed if the airman had a grade less than E-3 and less than one year of service. Otherwise, the airman was considered to have transferred in from another AFSC population.

PHASE 5 - DESCRIBE AND DEMONSTRATE THE OPERATION OF THE PAM

In Phase 3, the PAM was defined as a finite state personnel inventory projection model that treats the Air Force manpower system as a Markov process. The model was developed to investigate the current HR in the AF and to project personnel availability in the future. To efficiently accomplish this task, two computer programs were written to perform four functions.

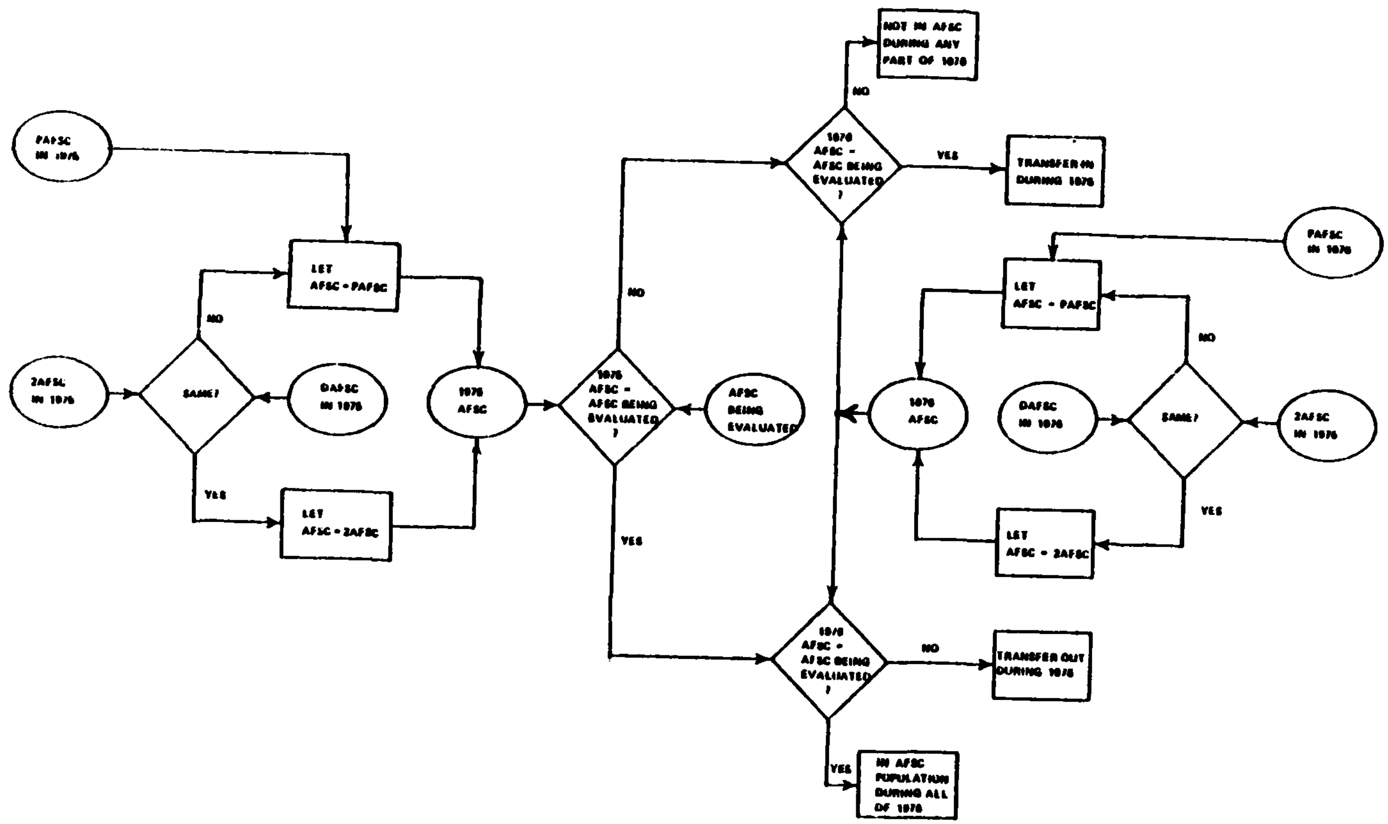


Figure 8 - Transfer Determniation

Program	Subroutine	Functions
1	-	Data Base Generation
2	1	Data Base Maintenance
2	2	Extrapolation
2	3	Data Post-Processing

Each function is performed by the program or program subroutine. In addition, the functions are sequential in that the output of one serves as the input to the next. The following paragraphs define each of the four functions and briefly describe the operation of the PAM as specified by its system design (see Figure 9).

PROGRAM 1: Data Base Generation Function

The PAM data base is extracted from the UAR data base. PROGRAM 1 first selects UAR personnel files to process on the basis of user-selected criteria for screening particular personnel attributes. It then processes the selected files and uses them to create matrices to be operated upon by subroutines two and three of the PAM PROGRAM 2. Once the files have been processed to establish an operating data base, the program calculates probabilities of upgrade, increments, and loss for each AFSC, paygrade, and years of service as described in PHASE 3 of this report. The PAM PROGRAM 1 also accumulates matrices for the number of transfers by AFSC, years of service, and paygrade.

PROGRAM 2: Subroutine 1: Data Base Maintenance Function

This subroutine allows the user to alter the operating data base (such as to modify the state, probability, or transfer matrices on an element-by-element basis). Such modifications allow a user to reflect, in the operating data base, the possible effects attributed to personnel policy changes or other conditions which may affect personnel transition probabilities. The subroutine also performs edit checks to assure that the data are consistent (such that $P_i = 1$). Use of this subroutine is optional and can be bypassed if the user has no reason to effect changes in the matrices computed from the input data in PROGRAM 1.

PROGRAM 2 - Subroutine 2: Data Base Maintenance Function

This subroutine produces the projections of personnel availability using the matrices calculated in PROGRAM 1, if and as amended by PROGRAM 2 - Subroutine 1. It steps the state matrix forward, year-by-year, and stores the output in a result file for future printing on a selective basis (for example, only certain years, paygrades, or years of service might be desired in a printout).

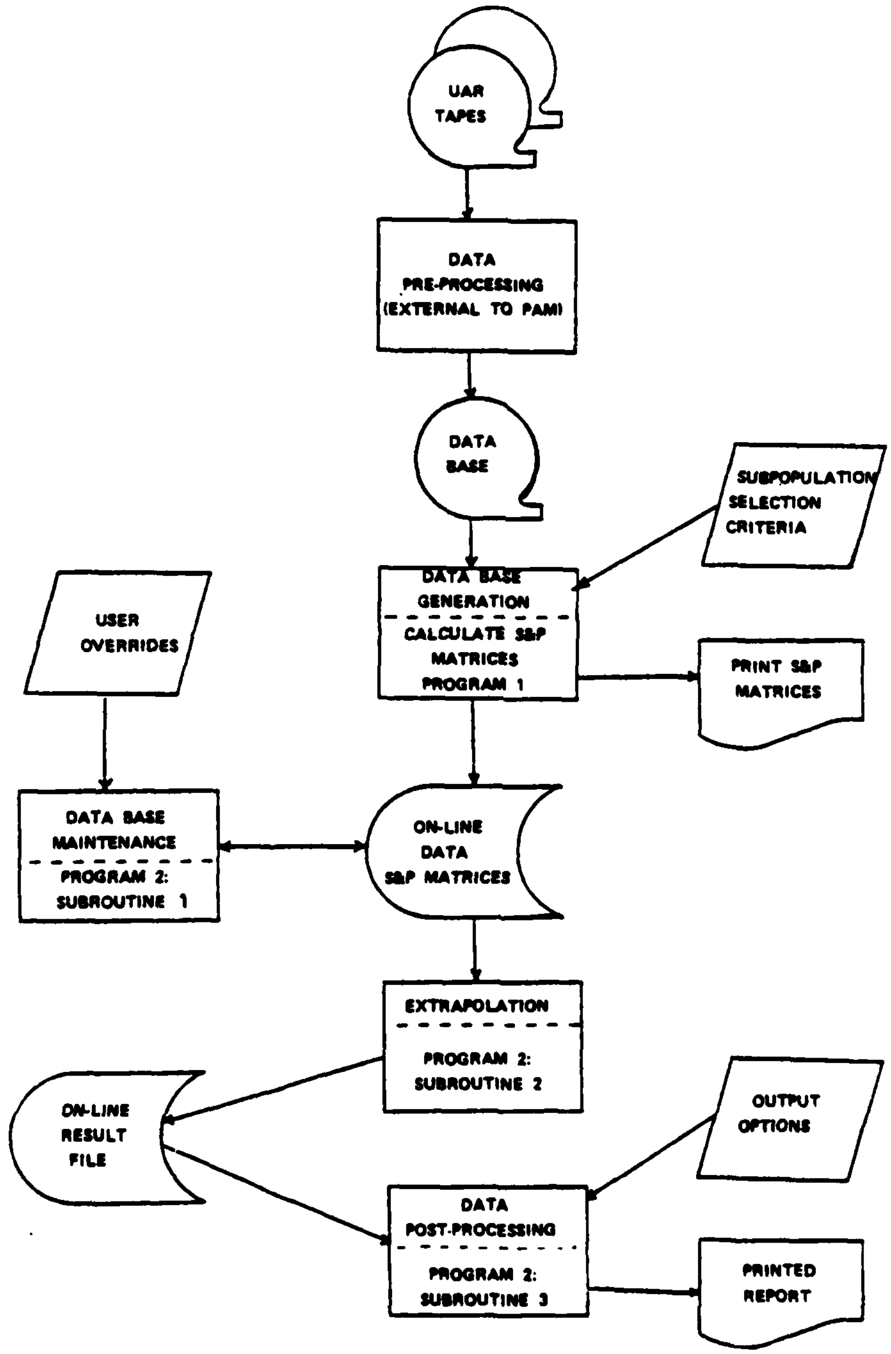


Figure 9 - The PAM design.

PROGRAM 2 - Subroutine 3: Data Post-Processing Function

This subroutine selectively lists any part of the result file output by Subroutine 2. The portion to be printed is selected by the user interactively on a timesharing computer terminal. Printed output parameters are selected by the user request. Output may be printed in the following formats.

1. The entire state matrix for paygrades 3 through 9 and YOS 1 through 21 (YOS 21 represents the combined YOS 22 through 30)

2. Any selected combination of states

3. Summed across paygrades

4. Summed across years of service (YOS)

5. The total number in all states (all paygrades and YOSs summed)

These outputs can be used to display the state information on the personnel inventory of the subpopulation under investigation for the current or any future year. All of the functions related to PROGRAM 2 are controlled interactively by the user at a computer terminal. Based on user responses to a series of questions displayed at the terminal, *program execution automatically selects Subroutines 1, 2, or 3 depending* upon the specific requirements of a user-defined task. Each time user input is required, a statement followed by a question mark is displayed to prompt the user. At that time, program execution pauses for the user response and resumes once the response is entered. The user must depress the carriage return key to enter a response to the program.

A sample run of the PAM programs using the 423xØ/male subpopulation in 1975-1976 is provided in Appendix D.

CONCLUSION

The PAM was developed to analyze current HR availability and make projections concerning HR availability at a user-specified future date. The model currently uses 1975 and 1976 UAR data for personnel within 13 selected maintenance AFSCs as data base, but any two-year set of UARs can be used to establish baseline probabilities. This allows the PAM to project the availability of any group of personnel of interest to the Air Force. For a given HR category defined by technical specialty, the PAM projects the future population by the year of service and paygrade within each category. The model accomplishes this by projecting career transition activity.

At present, the PAM is limited to projections involving the 13 AFSCs now included in the data bank. However, expansion of its coverage to include additional AFSCs involves straightforward input of additional UAR data to the data bank.

A maintenance function of the PAM computer programs allows the user to identify and alter model parameters (computed from the data) to accommodate changes in user interest and insight with respect to the career transition projection process. Projections may be adjusted as based upon either the expected impact of personnel policy decisions, or anticipated environmental changes.

The effort described in this report resulted in the attainment of the specific objective stated earlier. As with any model, the PAM has both operational limitations and advantages. The limitations and advantages will be discussed further in reports AFHRL-TR-79-67 and AFHRL-TR-79-68.

REFERENCES

Goclowski, J.C., LoFaso, A.J., Peskoe, S.E., & Baran, H.A. Air Force personnel availability analysis: Program description for the Personnel Availability Model (PAM). AFHRL-TR-79-68. Wright-Patterson AFB, OH: Logistics and Technical Training Division, Air Force Human Resources Laboratory, August 1980.

Goclowski, J.C., Peskoe, S.E., LoFaso, A.J., Vaughan, J., & Baran, H.A. Air Force personnel availability analysis: Application techniques of the Personnel Availability Model (PAM). AFHRL-TR-79-67. Wright-Patterson AFB, OH: Logistics and Technical Training Division, Air Force Human Resources Laboratory, August 1980.

APPENDIX A - MODELS REVIEWED

The models reviewed can be divided into six categories.

Category I	Manpower Requirements
Category II	Active Inventory
Category III	Inventory Projection
Category IV	Requirements/Inventory Analysis and Projection
Category V	Policy Generator
Category VI	Productivity Measurement

The design requirements of PAM calls for some capability in all of these categories. Yet the application of each reviewed model was found to be limited to a single category. Furthermore, no existing model was identified for inclusion in Category IV, the most important category in the PAM design. Consequently, no model was deemed suitable for modification to meet PAM design requirements. Lists of the models in each category are provided below.

CATAEGORY I - MANPOWER REQUIREMENTS MODELS

AFHRL, Simplified Approach to a Manpower Management Model, AD688 538.

Department of the Navy, Billet/Position Converter and Optimizer (BILCO) for the Navy Manpower Requirements System (MNRS); 31 October 1975.

Naval Personnel & Training Research Lab, New Concepts in Enlisted Personnel Planning, AD OP43 07XC1; May 1971.

Naval Post Graduate School, Manpower Stocks and Flow in a Rank Structured Hierarchy, AD A026 322; March 1976.

NAVCOSSACT, Manpower Analysis and Systems Development Branch, CNOCOM/MIS Support for the Navy Manpower Planning System (NAMPS), AD A000 969; 24 September 1974.

NPDRC, Enlisted Rotation Management: Users Guide to the Computerized Equilibrium Flow Model, AD OP 43 07XC3.

Rand Corporation, The Supply of Air Force Volunteers; September 1970.

The University of Texas, An Integrated Workload and Manpower Planning System for the Naval Air Rework Facility, AD A006, 393; November 1974.

CATEGORY II - ACTIVE INVENTORY MODELS

Naval Personnel Research & Development Lab, Computer Models for Manpower and Personnel Management: State of Current Technology (with Emphasis on Naval Operational Models), AD 761 613; 15 April 1973.

Naval Post Graduate School, Analysis of Some Two Characteristic Markov-Type Manpower Flow Models with Retraining Applications, AD 782 492; June 1974.

Naval Post Graduate School, Mini-Fast--An Interactive Model of the Navy's Enlisted Personnel System, NPS-55 Bd76081; August 1976.

Rand Corporation, A Computer Program and Model for Predicting the Supply of Air Force Volunteers, AD 749 123; May 1972.

Rand Corporation, Officer Grade Limitation Model, A Steady State Math Model of USAF Officers.

University of California, Longitudinal Manpower Planning Models, AD 769 221.

University of Texas at Austin, Application of the Navy Average Grade Model to the Naval Underwater Systems Center, AD 770 056; March 1973.

CATEGORY III - INVENTORY PROJECTION MODELS

AFHRL, Progression Prediction of Airmen E Type PC Moves, AD 781 036.

Naval Personnel Research & Development Center, A Model for the Prediction of Advancements in the Navy Enlisted Force, AD A0300 33; June 1976.

Naval Post Graduate School, A Semi-Markov Model for Military Officer Personnel Systems, AD 734 972; September 1971.

Naval Post Graduate School, Two Characteristic Markov Type Manpower Flow Models, AD A 001 261; July 1974.

Naval Post Graduate School, Personnel System Projection Model, AD 752 279.

Rand Corporation, A Markovian Flow Model: The Analysis of Movement in Large Scale (Military) Personnel System; February 1971.

CATEGORY IV - REQUIREMENTS/INVENTORY ANALYSIS AND PROJECTION MODELS

Of all models reviewed, none was found to provide the interface between weapon system requirements and projected human resource availability. Therefore, no models are listed in this category.

CATEGORY V - POLICY GENERATOR MODELS

Air University, Cost/Effectiveness of Air Force All Volunteer Force Programs, AD 920 615; May 1974.

American Institute for Research, The Current Status of Enlisted Attrition in the U.S. Navy and in the U.S. Marine Corps and the Search for Remedies, AD A018 234; November 1975.

Center for Naval Analysis, Models for Estimating Premature Losses and Recruitment District Performance, AD A020 433.

Cornell University, NROTC, The Design and Analysis of an Expectancy Theory Model for Predicting Early Retirement, AD 782 563; 5 July 1974.

MacGowan, R. A. & Shinpaugh, Capt. R. L. (USAF), Personnel Policy Simulation; 6 January 1977.

Quisenberry, Tandy B., The Development of Computerized Techniques for Enlisted Advancement Planning, AD 748 597; July 1972.

University of Texas, Organizational Test of a Static Multi Attribute Assignment Model, AD A00 5904.

CATEGORY VI - PRODUCTIVITY MEASUREMENT MODELS

BDM, Modeling Survey: Relative to the Development of a Demographic Model for Related Force Management, Vol. D 105 334.

B-K Dynamics, Inc., Development of Utility Measures for Manpower Planning; 28 February 1973.

B-K Dynamics, Inc., Utility Theory and Optimization in Military Personnel Management; 15 January 1975.

General Research Corp., CHAMP: A Chance Constrained Adaptive Planning Model, AD 773 051; December 1973.

Institute of Behavioral Research, Correlates of First-Term Reenlistment Behavior Aboard Navy Ships, AD A015 687; 1 May 1975.

APPENDIX B - THE PAM DATA BASE

The UAR file maintained at HQ AFHRL contains personnel data on all active duty enlisted airmen. Each UAR includes military service dates, grade, AF specialties, education level, current and projected duty assignment, aptitude, and dependents. A file update has been received semi-annually from the Military Personnel Center since June 1966. A less comprehensive file was received semi-annually from December 1964 to June 1966. Each UAR file update consists of approximately 600,000 records (in June 1975 there were 503,203 records), which are submitted on 16 reels of magnetic tape. The full-sized file contains records which are each a maximum of 2424 characters in length. Three other files are also maintained: (a) a 1302-character reocrd file on 16 reels containing the latest block of information and all data carried in the fixed portion of the full-sized file; (b) a 726-character record file on eight reels containing only the data from the fixed portion of the full-sized file; and, (c) a 168-character record file on two reels containing only key data elements. The data base used in developing PAM was extracted from the 1975 and 1976 UARs for 95,000 airmen assigned to 13 AFSCs at the end of those two years.

APPENDIX C - MECHANICS OF THE PAM

The PAM partitions the manpower system into discrete states defined by YOS and paygrade. Assuming Y possible years of service and G different paygrades, there are $K = Y \times G$ distinct states in the manpower system.

In general, the total population (S) or the i^{th} subpopulation in a system at time t is a random variable (R) which depends on the history of recruits coming into the system (including transfers from other AFSCs as well as the initial-entry personnel) and the probable movement (P) of personnel out of each (K) system state during the year. The PAM projection is based on the expected value of this random variable as a function of time. This projection is based on a constant recruitment rate, unless the analyst manually inserts expected recruitment values for future years. Assuming that transitions between states proceed in a Markov fashion, Equation C1 can be applied recursively to yield the expected state subpopulations at time t+1 as a function of the prior subpopulations and the recruitment history up to time t+1.

Equation C1: $S_i(t+1) = S_i(t)\ P_i + R_i\ (t+1)$

where:

$S_i(t+1)$ is the population vector $[S1_i(t+1), S2_i(t+1) \ldots Sk_i(t+1), \ldots SK_i(t+1)]$, which consists of the number of airmen in the k^{th} state at time t+1 that are members of the i^{th} subpopulation.

$S_i(t)$ is the population vector at time t

P_i is the probability matrix, $[P1_i, P2_i, \ldots PK_i, \ldots PK_i]$, of an airman in the i^{th} subpopulation transitioning into the k^{th} state.

$R_i(t+1)$ is the recruitment vector, $r_i(t+1)P_i$, which consists of the number of recruits for the i^{th} subpopulation at time t+1 and the probability that a recruit will transition into the k^{th} state.

Given an initial population S(o), the recursive application of Equation 1 over a period of time from year n=0 to year n=t yields Equation C2.

Equation C2: $S_i(t+1) = S(o)P_i^{(t+1)} + P_i \sum_{n=0}^{t} r(n+1)P_i^{(t-n)}$

Note that the future population is expressed as a function of the initial population, the recruitment history, and powers of the transition probability matrix.

The AF manpower system is hierarchical. That is, a person in a given paygrade and a given year of service can generally transition only to a higher or equivalent paygrade and a higher year of service by remaining in the system. Therefore, the transition probability matrix (P) must be upper triangular with zeros along the diagonal. For such a matrix, the value of $P^{(t+1)}$ approaches zero as t increases. Consequently, in the limit, the equilibrium population vector can be expressed as Equation C3.

$$\text{Equation C3: } S_i(t+1) = P_i \sum_{n=0}^{t} r(n+1)P_i^{(t-n)} \text{ for } t >> 0$$

In the special case of constant recruitment, $r_i(t) = r_i$, the equilibrium population vector can be expressed as Equation C4.

$$\text{Equation C4: } S_i(t+1) = r_i P_i [1-P_i]^{-1} \text{ for } t >> 0 \text{ and } r_i(t) = r_i$$

This constant recruitment function was used in the model to project expected vectors for the homogeneous subpopulations identified by the deriving attributes described in AFHRL-TR-79-67. At any point in the above analysis, the vectors can be summed over the subpopulation index (i) to yield the total population vector. Thus Equation C5 computes the expected AF state vector at time t+1, assuming m homogeneous subpopulations.

$$\text{Equation C5: } S(t+1) = \sum_{i=1}^{m} S_i(t+1)$$

APPENDIX D - SAMPLE OF THE PAM OUTPUT

The following pages contain the output of a sample run of the PAM programs. This run used the 423xØ/male subpopulation in 1975 and 1976. (Note that user input is indicated with double underlining.)

ENTER DATA FILE AND RESULT FILE (I.E. SUBPOP,RESULT)? 423XOM,RESULT

MAINT,RUN,PRINT, OR END? R

HOW MANY PROJECTION YEARS ARE DESIRED FOR RUN? 5
RUN COMPLETED

MAINT,RUN,PRINT, OR END? P

RESULT, MATRIX, OR END (R,M, OR E)? R

PAYGRADES? ALL

YEARS OF SERVICE? ALL

PROJECTION YEARS? 1975,1979

YEAR 1975

PAYGRADE:	3	4	5	6	7	8	9
YOS= 1	800.	0.	0.	0.	0.	0.	0.
LOSSES:	0.	0.	0.	0.	0.	0.	0.
YOS= 2	158.	0.	0.	0.	0.	0.	0.
LOSSES:	15.	0.	0.	0.	0.	0.	0.
YOS= 3	508.	8.	0.	0.	0.	0.	0.
LOSSES:	101.	0.	0.	0.	0.	0.	0.
YOS= 4	260.	142.	0.	0.	0.	0.	0.
LOSSES:	33.	20.	0.	0.	0.	0.	0.
YOS= 5	12.	411.	11.	0.	0.	0.	0.
LOSSES:	11.	223.	4.	0.	0.	0.	0.
YOS= 6	2.	110.	17.	0.	0.	0.	0.
LOSSES:	1.	12.	1.	0.	0.	0.	0.
YOS= 7	1.	62.	48.	0.	0.	0.	0.
LOSSES:	0.	4.	3.	0.	0.	0.	0.
YOS= 8	0.	60.	72.	0.	0.	0.	0.
LOSSES:	0.	10.	9.	0.	0.	0.	0.
YOS= 9	0.	41.	135.	1.	0.	0.	0.
LOSSES:	0.	10.	9.	0.	0.	0.	0.
YOS=10	0.	11.	99.	0.	0.	0.	0.
LOSSES:	0.	0.	5.	0.	0.	0.	0.
YOS=11	0.	1.	48.	1.	0.	0.	0.
LOSSES:	0.	0.	0.	0.	0.	0.	0.
YOS=12	0.	1.	21.	3.	0.	0.	0.
LOSSES:	0.	0.	1.	0.	0.	0.	0.
YOS=13	0.	0.	33.	14.	0.	0.	0.
LOSSES:	0.	0.	0.	0.	0.	0.	0.
YOS=14	0.	0.	20.	13.	0.	0.	0.
LOSSES:	0.	0.	0.	0.	0.	0.	0.
YOS=15	0.	0.	36.	20.	4.	0.	0.
LOSSES:	0.	0.	0.	0.	0.	0.	0.
YOS=16	0.	0.	34.	46.	5.	0.	0.
LOSSES:	0.	0.	0.	0.	0.	0.	0.
YOS=17	0.	1.	24.	35.	1.	0.	0.
LOSSES:	0.	0.	1.	0.	0.	0.	0.
YOS=18	0.	0.	6.	12.	4.	0.	0.
LOSSES:	0.	0.	0.	0.	0.	0.	0.
YOS=19	0.	0.	13.	49.	19.	0.	0.
LOSSES:	0.	0.	0.	0.	1.	0.	0.
YOS=20	0.	0.	17.	56.	22.	0.	0.
LOSSES:	0.	0.	0.	0.	0.	0.	0.
YOS=21	1.	0.	21.	113.	111.	39.	19.
LOSSES:	1.	0.	17.	54.	29.	10.	3.

YEAR 1976

PAYGRADE:	3	4	5	6	7	8	9
YOS= 1	600.	0.	0.	0.	0.	0.	0.
LOSSES:	0.	0.	0.	0.	0.	0.	0.
YOS= 2	802.	0.	0.	0.	0.	0.	0.
LOSSES:	76.	0.	0.	0.	0.	0.	0.
YOS= 3	33.	110.	0.	0.	0.	0.	0.
LOSSES:	6.	0.	0.	0.	0.	0.	0.
YOS= 4	285.	134.	0.	0.	0.	0.	0.
LOSSES:	36.	18.	0.	0.	0.	0.	0.
YOS= 5	5.	326.	17.	0.	0.	0.	0.
LOSSES:	5.	178.	6.	0.	0.	0.	0.
YOS= 6	0.	112.	87.	0.	0.	0.	0.
LOSSES:	0.	13.	5.	0.	0.	0.	0.
YOS= 7	0.	54.	58.	0.	0.	0.	0.
LOSSES:	0.	3.	3.	0.	0.	0.	0.
YOS= 8	1.	37.	61.	0.	0.	0.	0.
LOSSES:	0.	6.	7.	0.	0.	0.	0.
YOS= 9	0.	29.	91.	0.	0.	0.	0.
LOSSES:	0.	7.	6.	0.	0.	0.	0.
YOS=10	0.	15.	132.	1.	0.	0.	0.
LOSSES:	0.	0.	6.	0.	0.	0.	0.
YOS=11	0.	5.	89.	0.	0.	0.	0.
LOSSES:	0.	0.	0.	0.	0.	0.	0.
YOS=12	0.	0.	46.	3.	0.	0.	0.
LOSSES:	0.	0.	2.	0.	0.	0.	0.
YOS=13	0.	1.	18.	4.	0.	0.	0.
LOSSES:	0.	0.	0.	0.	0.	0.	0.
YOS=14	0.	0.	26.	18.	0.	0.	0.
LOSSES:	0.	0.	0.	0.	0.	0.	0.
YOS=15	0.	0.	14.	21.	2.	0.	0.
LOSSES:	0.	0.	0.	0.	0.	0.	0.
YOS=16	0.	0.	21.	32.	6.	0.	0.
LOSSES:	0.	0.	0.	0.	0.	0.	0.
YOS=17	0.	0.	26.	48.	8.	0.	0.
LOSSES:	0.	0.	1.	0.	0.	0.	0.
YOS=18	0.	1.	19.	32.	5.	0.	0.
LOSSES:	0.	0.	0.	0.	0.	0.	0.
YOS=19	0.	0.	4.	10.	8.	1.	0.
LOSSES:	0.	0.	0.	0.	0.	0.	0.
YOS=20	0.	0.	6.	45.	30.	0.	0.
LOSSES:	0.	0.	0.	0.	0.	0.	0.
YOS=21	0.	0.	13.	50.	37.	30.	17.
LOSSES:	0.	0.	11.	24.	9.	8.	2.

YEAR 1977

PAYGRADE:	3	4	5	6	7	8	9
YOS= 1	600.	0.	0.	0.	0.	0.	0.
LOSSES:	0.	0.	0.	0.	0.	0.	0.
YOS= 2	602.	0.	0.	0.	0.	0.	0.
LOSSES:	57.	0.	0.	0.	0.	0.	0.
YOS= 3	163.	554.	0.	0.	0.	0.	0.
LOSSES:	32.	0.	0.	0.	0.	0.	0.
YOS= 4	18.	116.	8.	0.	0.	0.	0.
LOSSES:	2.	16.	0.	0.	0.	0.	0.
YOS= 5	6.	342.	16.	0.	0.	0.	0.
LOSSES:	6.	186.	5.	0.	0.	0.	0.
YOS= 6	0.	98.	76.	0.	0.	0.	0.
LOSSES:	0.	10.	4.	0.	0.	0.	0.
YOS= 7	0.	54.	109.	0.	0.	0.	0.
LOSSES:	0.	3.	6.	0.	0.	0.	0.
YOS= 8	0.	32.	67.	0.	0.	0.	0.
LOSSES:	0.	5.	8.	0.	0.	0.	0.
YOS= 9	0.	18.	74.	0.	0.	0.	0.
LOSSES:	0.	4.	5.	0.	0.	0.	0.
YOS=10	0.	11.	93.	0.	0.	0.	0.
LOSSES:	0.	0.	4.	0.	0.	0.	0.
YOS=11	0.	7.	121.	1.	0.	0.	0.
LOSSES:	0.	0.	0.	0.	0.	0.	0.
YOS=12	0.	0.	89.	4.	0.	0.	0.
LOSSES:	0.	0.	4.	0.	0.	0.	0.
YOS=13	0.	0.	40.	7.	0.	0.	0.
LOSSES:	0.	0.	1.	0.	0.	0.	0.
YOS=14	0.	0.	14.	7.	0.	0.	0.
LOSSES:	0.	0.	0.	0.	0.	0.	0.
YOS=15	0.	0.	17.	28.	2.	0.	0.
LOSSES:	0.	0.	0.	0.	0.	0.	0.
YOS=16	0.	0.	9.	24.	5.	0.	0.
LOSSES:	0.	0.	0.	0.	0.	0.	0.
YOS=17	0.	0.	17.	32.	8.	0.	0.
LOSSES:	0.	0.	0.	0.	0.	0.	0.
YOS=18	0.	0.	22.	43.	7.	0.	0.
LOSSES:	0.	0.	0.	0.	0.	0.	0.
YOS=19	0.	0.	16.	30.	12.	1.	0.
LOSSES:	0.	0.	0.	0.	1.	0.	0.
YOS=20	0.	0.	2.	11.	14.	0.	0.
LOSSES:	0.	0.	0.	0.	0.	0.	0.
YOS=21	0.	0.	5.	39.	41.	30.	17.
LOSSES:	0.	0.	4.	18.	11.	8.	2.

YEAR 1979

PAYGRADE:	3	4	5	6	7	8	9
YOS= 1	600.	0.	0.	0.	0.	0.	0.
LOSSES:	0.	0.	0.	0.	0.	0.	0.
YOS= 2	602.	0.	0.	0.	0.	0.	0.
LOSSES:	57.	0.	0.	0.	0.	0.	0.
YOS= 3	123.	416.	0.	0.	0.	0.	0.
LOSSES:	24.	0.	0.	0.	0.	0.	0.
YOS= 4	69.	419.	33.	0.	0.	0.	0.
LOSSES:	8.	59.	0.	0.	0.	0.	0.
YOS= 5	2.	477.	66.	0.	0.	0.	0.
LOSSES:	1.	260.	24.	0.	0.	0.	0.
YOS= 6	0.	34.	35.	0.	0.	0.	0.
LOSSES:	0.	4.	2.	0.	0.	0.	0.
YOS= 7	0.	46.	97.	0.	0.	0.	0.
LOSSES:	0.	3.	6.	0.	0.	0.	0.
YOS= 8	0.	26.	92.	0.	0.	0.	0.
LOSSES:	0.	4.	11.	0.	0.	0.	0.
YOS= 9	0.	16.	109.	0.	0.	0.	0.
LOSSES:	0.	4.	8.	0.	0.	0.	0.
YOS=10	0.	6.	78.	0.	0.	0.	0.
LOSSES:	0.	0.	4.	0.	0.	0.	0.
YOS=11	0.	3.	69.	0.	0.	0.	0.
LOSSES:	0.	0.	0.	0.	0.	0.	0.
YOS=12	0.	0.	85.	4.	0.	0.	0.
LOSSES:	0.	0.	4.	0.	0.	0.	0.
YOS=13	0.	0.	104.	17.	0.	0.	0.
LOSSES:	0.	0.	3.	1.	0.	0.	0.
YOS=14	0.	0.	61.	24.	0.	0.	0.
LOSSES:	0.	0.	0.	0.	0.	0.	0.
YOS=15	0.	0.	21.	25.	2.	0.	0.
LOSSES:	0.	0.	0.	0.	0.	0.	0.
YOS=16	0.	0.	7.	16.	4.	0.	0.
LOSSES:	0.	0.	0.	0.	0.	0.	0.
YOS=17	0.	0.	9.	30.	8.	0.	0.
LOSSES:	0.	0.	0.	0.	0.	0.	0.
YOS=18	0.	0.	6.	20.	3.	0.	0.
LOSSES:	0.	0.	0.	0.	0.	0.	0.
YOS=19	0.	0.	12.	26.	11.	1.	0.
LOSSES:	0.	0.	0.	0.	1.	0.	0.
YOS=20	0.	0.	10.	40.	27.	0.	0.
LOSSES:	0.	0.	0.	0.	0.	0.	0.
YOS=21	0.	0.	6.	28.	33.	30.	17.
LOSSES:	0.	0.	5.	13.	9.	8.	2.

YEAR 1978

PAYGRADE:	3	4	5	6	7	8	9
YOS= 1	600.	0.	0.	0.	0.	0.	0.
LOSSES:	0.	0.	0.	0.	0.	0.	0.
YOS= 2	602.	0.	0.	0.	0.	0.	0.
LOSSES:	57.	0.	0.	0.	0.	0.	0.
YOS= 3	123.	416.	0.	0.	0.	0.	0.
LOSSES:	24.	0.	0.	0.	0.	0.	0.
YOS= 4	92.	556.	44.	0.	0.	0.	0.
LOSSES:	11.	78.	0.	0.	0.	0.	0.
YOS= 5	0.	106.	14.	0.	0.	0.	0.
LOSSES:	0.	58.	5.	0.	0.	0.	0.
YOS= 6	0.	94.	78.	0.	0.	0.	0.
LOSSES:	0.	11.	4.	0.	0.	0.	0.
YOS= 7	0.	44.	94.	0.	0.	0.	0.
LOSSES:	0.	2.	5.	0.	0.	0.	0.
YOS= 8	0.	32.	106.	0.	0.	0.	0.
LOSSES:	0.	5.	13.	0.	0.	0.	0.
YOS= 9	0.	16.	78.	0.	0.	0.	0.
LOSSES:	0.	4.	5.	0.	0.	0.	0.
YOS=10	0.	7.	76.	0.	0.	0.	0.
LOSSES:	0.	0.	3.	0.	0.	0.	0.
YOS=11	0.	5.	85.	0.	0.	0.	0.
LOSSES:	0.	0.	0.	0.	0.	0.	0.
YOS=12	0.	0.	120.	6.	0.	0.	0.
LOSSES:	0.	0.	5.	0.	0.	0.	0.
YOS=13	0.	0.	77.	13.	0.	0.	0.
LOSSES:	0.	0.	2.	0.	0.	0.	0.
YOS=14	0.	0.	31.	13.	0.	0.	0.
LOSSES:	0.	0.	0.	0.	0.	0.	0.
YOS=15	0.	0.	10.	13.	2.	0.	0.
LOSSES:	0.	0.	0.	0.	0.	0.	0.
YOS=16	0.	0.	11.	31.	5.	0.	0.
LOSSES:	0.	0.	0.	0.	0.	0.	0.
YOS=17	0.	0.	7.	23.	7.	0.	0.
LOSSES:	0.	0.	0.	0.	0.	0.	0.
YOS=18	0.	0.	14.	29.	4.	0.	0.
LOSSES:	0.	0.	0.	0.	0.	0.	0.
YOS=19	0.	0.	18.	40.	16.	1.	0.
LOSSES:	0.	0.	0.	0.	1.	0.	0.
YOS=20	0.	0.	8.	31.	21.	0.	0.
LOSSES:	0.	0.	0.	0.	0.	0.	0.
YOS=21	0.	0.	2.	10.	25.	30.	17.
LOSSES:	0.	0.	1.	5.	6.	8.	2.

PRINT ANOTHER MATRIX (Y OR N)? Y

MATRIX NAME? PL

PL MATRIX:

PAYGRADE:	3	4	5	6	7	8	9
YOS= 1	0.	0.	0.	0.	0.	0.	0.
YOS= 2	0.095	0.	0.	0.	0.	0.	0.
YOS= 3	0.200	0.	0.	0.	0.	0.	0.
YOS= 4	0.127	0.141	0.	0.	0.	0.	0.
YOS= 5	0.917	0.545	0.364	0.	0.	0.	0.
YOS= 6	0.500	0.118	0.059	0.	0.	0.	0.
YOS= 7	0.	0.065	0.063	0.	0.	0.	0.
YOS= 8	0.	0.167	0.125	0.	0.	0.	0.
YOS= 9	0.	0.268	0.074	0.	0.	0.	0.
YOS=10	0.	0.	0.051	0.	0.	0.	0.
YOS=11	0.	0.	0.	0.	0.	0.	0.
YOS=12	0.	0.	0.048	0.	0.	0.	0.
YOS=13	0.	0.	0.030	0.071	0.	0.	0.
YOS=14	0.	0.	0.	0.	0.	0.	0.
YOS=15	0.	0.	0.	0.	0.	0.	0.
YOS=16	0.	0.	0.	0.	0.	0.	0.
YOS=17	0.	0.	0.042	0.	0.	0.	0.
YOS=18	0.	0.	0.	0.	0.	0.	0.
YOS=19	0.	0.	0.	0.	0.105	0.	0.
YOS=20	0.	0.	0.	0.	0.	0.	0.
YOS=21	1.000	0.	0.857	0.478	0.270	0.282	0.158

PRINT ANOTHER MATRIX (Y OR N)? Y

MATRIX NAME? PI

PI MATRIX:

PAYGRADE:	3	4	5	6	7	8	9
YOS= 1	1.000	0.	0.	0.	0.	0.	0.
YOS= 2	0.203	0.	0.	0.	0.	0.	0.
YOS= 3	0.562	0.920	0.	0.	0.	0.	0.
YOS= 4	0.023	0.704	0.	0.	0.	0.	0.
YOS= 5	0.	0.254	0.636	0.	0.	0.	0.
YOS= 6	0.	0.467	0.706	0.	0.	0.	0.
YOS= 7	1.000	0.597	0.771	0.	0.	0.	0.
YOS= 8	0.	0.467	0.792	0.	0.	0.	0.
YOS= 9	0.	0.390	0.822	1.000	0.	0.	0.
YOS=10	0.	0.455	0.838	0.	0.	0.	0.
YOS=11	0.	0.	0.938	1.000	0.	0.	0.
YOS=12	0.	1.000	0.857	1.000	0.	0.	0.
YOS=13	0.	0.	0.788	0.929	0.	0.	0.
YOS=14	0.	0.	0.650	1.000	0.	0.	0.
YOS=15	0.	0.	0.583	0.850	0.500	0.	0.
YOS=16	0.	0.	0.794	0.875	0.800	0.	0.
YOS=17	0.	1.000	0.833	0.829	0.	0.	0.
YOS=18	0.	0.	0.833	0.833	1.000	0.	0.
YOS=19	0.	0.	0.538	0.776	0.789	0.	0.
YOS=20	0.	0.	0.765	0.839	0.727	0.	0.
YOS=21	0.	0.	0.	0.451	0.550	0.077	0.

ESULT, MATRIX, OR END (R,M, OR E)? M

ATRIX NAME? PU

U MATRIX:

AYGRADE:	3	4	5	6	7	8	9
OS= 1	0.	0.	0.	0.	0.	0.	0.
YOS= 2	0.690	0.	0.	0.	0.	0.	0.
OS= 3	0.234	0.080	0.	0.	0.	0.	0.
OS= 4	0.838	0.120	0.	0.	0.	0.	0.
OS= 5	0.083	0.179	0.	0.	0.	0.	0.
YOS= 6	0.500	0.324	0.	0.	0.	0.	0.
YOS= 7	0.	0.258	0.	0.	0.	0.	0.
YOS= 8	0.	0.333	0.	0.	0.	0.	0.
YOS= 9	0.	0.293	0.007	0.	0.	0.	0.
YOS=10	0.	0.545	0.010	0.	0.	0.	0.
YOS=11	0.	1.000	0.042	0.	0.	0.	0.
YOS=12	0.	0.	0.095	0.	0.	0.	0.
YOS=13	0.	0.	0.152	0.	0.	0.	0.
YOS=14	0.	0.	0.350	0.	0.	0.	0.
YOS=15	0.	0.	0.389	0.100	0.	0.	0.
YOS=16	0.	0.	0.176	0.083	0.	0.	0.
YOS=17	0.	0.	0.125	0.143	0.	0.	0.
YOS=18	0.	0.	0.167	0.167	0.	0.	0.
YOS=19	0.	0.	0.462	0.204	0.	0.	0.
YOS=20	0.	0.	0.235	0.143	0.	0.	0.
YOS=21	0.	0.	0.143	0.071	0.009	0.	0.

PRINT ANOTHER MATRIX (Y OR N)? N
PRINT RESULT (Y OR N)? Y

PAYGRADES? COL

YEARS OF SERVICE? ALL

PROJECTION YEARS? 1976,1979

COLLAPSED BY PAYGRADE:

	YEAR 1976		YEAR 1977		YEAR 1978		YEAR 1979	
YOS= 1	600.	LOSSES: 0.	600.	LOSSES: 0.	600.	LOSSES: 0.	600.	LOSSES: 0.
YOS= 2	902.	LOSSES: 76.	602.	LOSSES: 57.	602.	LOSSES: 57.	602.	LOSSES: 57.
YOS= 3	143.	LOSSES: 6.	717.	LOSSES: 32.	539.	LOSSES: 24.	539.	LOSSES: 24.
YOS= 4	419.	LOSSES: 54.	142.	LOSSES: 18.	692.	LOSSES: 89.	521.	LOSSES: 67.
YOS= 5	348.	LOSSES: 189.	364.	LOSSES: 197.	120.	LOSSES: 63.	545.	LOSSES: 285.
YOS= 6	199.	LOSSES: 18.	166.	LOSSES: 14.	172.	LOSSES: 15.	69.	LOSSES: 6.
YOS= 7	112.	LOSSES: 6.	163.	LOSSES: 9.	138.	LOSSES: 7.	143.	LOSSES: 9.
YOS= 8	99.	LOSSES: 13.	99.	LOSSES: 13.	138.	LOSSES: 18.	118.	LOSSES: 15.
YOS= 9	120.	LOSSES: 13.	92.	LOSSES: 9.	94.	LOSSES: 9.	125.	LOSSES: 12.
YOS=10	148.	LOSSES: 6.	104.	LOSSES: 4.	83.	LOSSES: 3.	84.	LOSSES: 4.
YOS=11	94.	LOSSES: 0.	129.	LOSSES: 0.	90.	LOSSES: 0.	72.	LOSSES: 0.
YOS=12	49.	LOSSES: 2.	93.	LOSSES: 4.	126.	LOSSES: 5.	89.	LOSSES: 4.
YOS=13	23.	LOSSES: 0.	47.	LOSSES: 1.	90.	LOSSES: 2.	121.	LOSSES: 4.
YOS=14	44.	LOSSES: 0.	21.	LOSSES: 0.	44.	LOSSES: 0.	95.	LOSSES: 0.
YOS=15	37.	LOSSES: 0.	47.	LOSSES: 0.	25.	LOSSES: 0.	48.	LOSSES: 0.
YOS=16	59.	LOSSES: 0.	38.	LOSSES: 6.	47.	LOSSES: 0.	27.	LOSSES: 0.
YOS=17	62.	LOSSES: 1.	57.	LOSSES: 0.	37.	LOSSES: 0.	47.	LOSSES: 0.
YOS=18	57.	LOSSES: 0.	72.	LOSSES: 0.	47.	LOSSES: 0.	29.	LOSSES: 0.
YOS=19	23.	LOSSES: 0.	59.	LOSSES: 1.	75.	LOSSES: 1.	50.	LOSSES: 1.
YOS=20	81.	LOSSES: 0.	27.	LOSSES: 8.	60.	LOSSES: 0.	77.	LOSSES: 0.
YOS=21	147.	LOSSES: 54.	132.	LOSSES: 43.	84.	LOSSES: 22.	114.	LOSSES: 37.

RESULT, MATRIX, OR END (R,M, OR E)? R

PAYGRADES? ALL

YEARS OF SERVICE? COL

PROJECTION YEARS? 1976,1979

COLLAPSED BY YOS:

YEAR 1976

PAYGRADE:	3	4	5	6	7	8	9
STATE:	1726.	824.	728.	264.	96.	31.	17.
LOSSES:	123.	225.	47.	24.	9.	8.	2.

YEAR 1977

PAYGRADE:	3	4	5	6	7	8	9
STATE:	1389.	1224.	795.	226.	89.	31.	17.
LOSSES:	97.	224.	41.	18.	12.	8.	2.

YEAR 1978

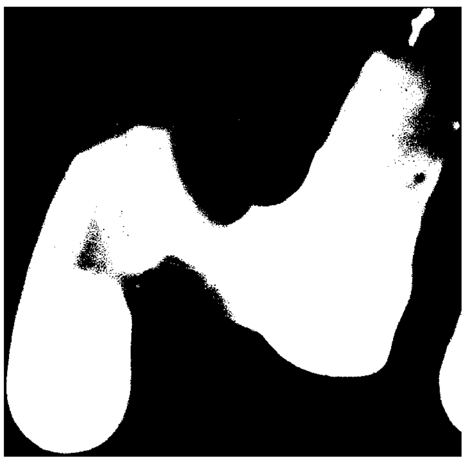
PAYGRADE:	3	4	5	6	7	8	9
STATE:	1417.	1276.	873.	209.	80.	31.	17.
LOSSES:	92.	158.	43.	5.	7.	8.	2.

YEAR 1979

PAYGRADE:	3	4	5	6	7	8	9
STATE:	1396.	1443.	900.	230.	88.	31.	17.
LOSSES:	90.	334.	67.	14.	10.	8.	2.

```
RESULT, MATRIX, OR END (R,M, OR E)? R

PAYGRADES? COL

YEARS OF SERVICE? COL

PROJECTION YEARS? 1,4

COLLAPSED BY PAYGRADE AND YOS:

YEAR  1975
STATE:      3834.
 LOSSES:       588.

YEAR  1976
STATE:      3686.
 LOSSES:       438.

YEAR  1977
STATE:      3771.
 LOSSES:       402.

YEAR  1978
STATE:      3903.
 LOSSES:       315.

RESULT, MATRIX, OR END (R,M, OR E)? R

PAYGRADES? COL

YEARS OF SERVICE? COL

PROJECTION YEARS? 5,5

COLLAPSED BY PAYGRADE AND YOS:

YEAR  1979
STATE:      4105.
 LOSSES:       525.

RESULT, MATRIX, OR END (R,M, OR E)? E

MAINT,RUN,PRINT, OR END? E
```

END
DATE
FILMED
DTIC



AD-A089 707   DYNAMICS RESEARCH CORP WILMINGTON MASS   F/G 15/5
AIR FORCE PERSONNEL AVAILABILITY ANALYSIS: A DESCRIPTION OF THE--ETC(U)
SEP 80 J C GOCLOWSKI, A J LOFASO, S E PESKOE   F33615-77-C-0032
UNCLASSIFIED   AFHRL-TR-79-66   NL

2 of 2

SUPPLEMENTARY INFORMATION

END
DATE FILMED
6-81
DTIC

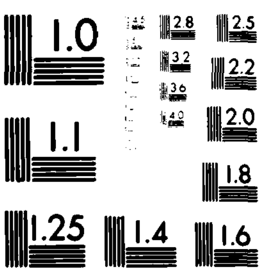
FIED

OF 2

A
9707

SUPP

INI



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

EMENTARY

ORMATION

DEPARTMENT OF THE AIR FORCE
ORCE HUMAN RESOURCES LABORATORY (AFSC)
BROOKS AIR FORCE BASE, TEXAS 78235

Errata

16 JAN 1981

Statement

ion Center
acker)

rt Control Statement which erroneously appears on
orts listed [redacted]. This statement is
o Statement B reports only.

tions to AFHRL/TSR, AUTOVON 240-3877.

m

l, USAF
Division

1 Atch
List of Reports

Cy to: AFHRL/TSE