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NEW CONCEPTS IN ENLISTED PERSONNEL PLANNING: INTRODUCTION TO THE ADSTAP SYSTEM

Joe Silverman

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INTRODUCTION TO THE ADSTAP SYSTEM

by

Joe Silverman

May 1971

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13. ABSTRACT

Requirements for naval personnel, both as to number and type of skill, are undergoing continual change. In addition, the personnel resources necessary to meet these requirements are similarly dynamic in nature, constantly changing in their availability and configuration. This situation places enormous demands on the naval personnel management system in planning the development, maintenance, and utilization of personnel inventories compatible with manpower requirements. The increasing criticality of this situation has intensified the Navy's effort to provide the personnel manager with advanced, computer-based methods to assist in planning and controlling personnel resources. Fundamentally, the purpose of this research is to investigate advances in computer technology and management science for possible application in the development of complex, large-scale, personnel planning decision systems. Such a System, termed ADSTAP (Advancement, Strength, and Training Plans), has been developed in terms of a tripartite structure. A planning data base is extracted from current and historical personnel accounting records and becomes input for a force structure Projection Model. The Model simulates the naval enlisted personnel system and produces output which constrains a wide range of planning programs and models concerned with strength levels, manpower budget, promotions, training, and other personnel functions. A prototype of the ADSTAP System is currently undergoing test and evaluation in the Bureau of Naval Personnel.

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The development of any complex management system owes much to the individuals performing the research, to the secretarial and clerical staff facilitating the work of project personnel, and to those offices lending budgetary and administrative support. Such is the case with the ADSTAP System, but in addition, a particular debt is owed to the ultimate beneficiaries of the System in the Bureau of Naval Personnel; namely, the organization headed by the Assistant Chief for Plans and Programs (Pers-A).

If not unique, the development of ADSTAP has at least been extraordinary in terms of participation by the direct consumer of the research--the Active Enlisted Plans Branch (Pers-A12). Their interest, ideas, encouragement, and support have played a significant role in both the direction of the research and its rapid development. To those dynamic, enlightened managers in Pers-A we acknowledge our debt and dedicate this report.

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SUMMARY AND CONCLUSIONS

Problem

Requirements for naval personnel, both as to number and type of skill, are undergoing continual change. This is due to a number of factors, including continuing advances and shifts in the character of technology, changing world conditions, and the volume and variety of domestic programs of a social and economic nature. In addition, oscillations in the financial resources allotted to defense and the changing composition of manpower resources available to the military services are manifested in continually changing requirements for naval officer and enlisted personnel. The dynamic nature of requirements places enormous demands on the naval personnel management system in planning the development, maintenance, and utilization of a personnel inventory compatible with manpower requirements. The focal point of this burden is the personnel manager, whatever the level or function--in short, the decision maker. The increasing criticality of this situation has intensified the Navy's effort to provide the personnel manager with advanced computer-based methods and techniques to assist in planning and controlling personnel resources in order to better meet changing qualitative and quantitative manpower requirements on a timely basis. Fundamentally, the purpose of this research is to investigate advances in computer technology and management science for possible application in the development of complex, large-scale, personnel planning decision systems.

Background

Under the direction of the Chief of Naval Personnel, this Laboratory is conducting a research program in the area of enlisted personnel planning. The thrust of this program is toward the development of computer-assisted decision systems for more effective personnel planning. Initially, however, this effort had its origins in research on striker ratios and petty officer ratios. In the course of these analyses it became apparent that the ability to achieve personnel management objectives is heavily dependent on actions taken in the area of enlisted promotions or advancements. This awareness generated an investigation of the processes underlying the advancement system, resulting in the development of new techniques for planning advancements, such as the Advancement Planning Model (ADPLAN I and II), a network flow advancement methodology, and an application of dynamic programming. As before, interrelationships in the enlisted personnel system led to research on processes of strength and budget planning which resulted in the development of a Strength Planning Model (SPAN) and a Budget Cost Management Program (BUCOMP). Because of the common need for information about future states of the system in all personnel planning, a comprehensive computer model was designed to simulate flows in the personnel system over time. This research produced a complex planning model (PROJECT) for use in making enlisted personnel force projections.

Since the development of these and other models are contingent on data in various forms and quantities it was necessary to build a large scale data bank for enlisted inventories and changes to those inventories over time (INCH), as well as special purpose data banks. It soon became clear that research in enlisted personnel planning was evolving toward the development of an integrated, comprehensive, complex, computer-based decision system--and that such a system was capable of yielding an exponential increase in the power of decision-making techniques. More in terms of its origins than its present state, the developing system was termed ADSTAP (Advancement, Strength, and Training Plans), of which a general description is provided in this report. It should be noted that this document is not so much a report of research findings as it is a statement of progress in an area of on-going research.

Approach

Current state-of-the-art is characterized by traditional methods employing "rule of thumb," restricted applications of conventional operations research techniques, widespread use of computers for data preparation, and numerous manpower and personnel simulation and projection modelsof limited utility. Experience over the years has shown a great proliferation in model building but inadequate ties to operational capabilities. Present effort is concerned with tightening methodological and operational constraints used in the development of manpower planning tools. This requires more patient development of suitable methods of problem analysis and more cogent definitions of manpower planning problems in terms of available mathemathical model building and computerized simulation techniques. The objective of this research approach is the development of an integrated, computerized enlisted personnel planning system.

Findings, Conclusions, and Recommendations

The ADSTAP System functionally and logically integrates the objectives of enlisted strength, training, and advancement planning. In its final form, the system will enable the planning managers to accommodate rapidly to modifications in requirements, to identify significant problem areas, and to test alternative enlisted plans and policies prior to their establishment. ADSTAP will also provide the capability to forecast qualitative and quantitative personnel requirements for long-range planning purposes. This capability will be based on the adaptation of recent advances in forecasting methodology in order to provide sufficiently accurate projected distributions of military personnel inventories for detailed budget estimates, as well as for policy testing. For short-range and mid-range enlisted personnel planning, the ADSTAP System will provide the capability of evaluating and controlling progress of current policies and programs. The development of the ADSTAP System will allow personnel planners to concentrate on the problem of planning, as opposed to present time-consuming practices associated with the calculation and preparation of planning reports and documents. More important is the fact that research in the enlisted planning area has resulted in the accumulation and organization of vast amounts of data in unique forms. This permits the use of comprehensive current and historical data in the decision-making process, not previously employed with the hand-tabulation and desk calculator methods to which managers were restricted. Thus, the quality of management planning, in addition to the speed of planning, is being improved by the use of computer technology. In this sense, then, the ultimate benefit of all manpower planning models will not simply reside in lessening the workload of personnel planners, but rather in permitting the redirection of managerial effort to the most effective ends. To serve the latter objective, the ADSTAP System provides a wide range of computer models and programs which give the enlisted personnel planner a capability in decision making and policy formulation that would not otherwise be possible.

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CONTENTS

NEW CONCEPTS IN ENLISTED PERSONNEL PLANNING: INTRODUCTION TO THE ADSTAP SYSTEM

INTRODUCTION

Purpose

The dynamic nature of both manpower requirements and personnel resources places enormous demands on the naval personnel management system in planning the development, maintenance, and utilization of personnel inventories that are sufficient to meet the needs of the fleet. The focal point of this burden is the personnel manager, whatever the level or function--in short, the decision maker. The increasing burden of personnel planning has intensified the Navy's effort to provide the personnel managers with advanced, computer-based methods and techniques to assist in planning and controlling personnel resources in order to fulfill changing qualitative and quantitative manpower requirements on a timely basis. The purpose of this report is to describe a research effort in personnel planning which constitutes a significant response to this problem.

Background

Under the direction of the Chief of Naval Personnel, this Laboratory is conducting a research program in the area of enlisted personnel planning, with the ultimate objective of developing computer-assisted decision systems. While working toward this objective, a large volume of useful personnel management information has been generated and a number of computerized personnel planning techniques have been developed and implemented. The personnel function most concerned with these research end products has been the Active Enlisted Plans Branch (Pers-A12) of the Bureau of Naval Personnel. This office is charged with the responsibility for determining recruit and training input, planning enlisted promotions, managing losses, planning incentive programs, evaluating grade structures, and controlling strength levels, among other functions.

Initially, this effort had its origins in research to determine the optimal ratios between the various petty officer pay grades,[1] and also between petty officers and non-rated personnel.[2] Such ratios indicate the "best" configuration of personnel at each pay grade. For example, for every man at pay grade E-7, there should be two at E-6, four at E-5, and eight at E-4; this would be a 1:2:4:8 petty officer ratio. Similarly, it is possible to develop a ratio of proportion between the force of petty officers and the non-rated population necessary to support that force.

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[1] Conner, R. D. and May, R. V., Jr., A Method for Developing Optimal Petty Officer Ratios, San Diego: U. S. Naval Personnel Research Activity, May 1965 (SRR 65-3).

[2] Conner, R. D., Preliminary Research Report on Determining Striker Requirements for Navy Ratings, San Diego: U. S. Naval Personnel Research Activity, May 1964 (Report No. 235).

In the course of these analyses it became apparent that a critical factor in achieving personnel management objectives is found in enlisted promotions or advancements. This awareness generated a program of research centering on the advancement system, and resulting in the development and implementation of new techniques for planning advancements. Among these are several generations of the Advancement Planning Model--ADPLAN I and II[3] which has been operationally used to determine enlisted promotions for the last three years. Additionally, other techniques have been devised, such as a network flow advancement methodology and an application of dynamic programming[4].

As before, interrelationships between advancement planning and other planning subsystems led to research on processes of strength and budget planning, which resulted in the development and implementation of several versions of The Strength Planning Model--SPAN and a Budget Cost Management Program--BUCOMP[5]. Because of the common need in all planning functions for information about future states of the system, research was initiated to design a comprehensive personnel projection model. This research produced a computer model called PROJECT which simulates flows in the personnel system over time.

Since the development of these and other models are grounded in data of various forms and quantities, it was necessary to build a large scale data bank containing historical enlisted inventories and changes to those inventories. It soon became clear that research in enlisted personnel planning was evolving toward the development of an integrated, comprehensive, complex, computer-based decision system--and that such a system was capable of yielding an exponential increase in the power of decision-making techniques. More in terms of its origins than its present state, the developing system was termed the ADSTAP System (Advancement, Strength, and Training Plans),[6] a general description of which is provided in this report.

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[3]Conner, R. D. and May, R. V., Jr., Computerized Enlisted Advancement Planning, San Diego: U. S. Naval Personnel Research Activity, June 1966 (SRR 66-21).

[4]Moonan, W. J. and Covher, M. H., A Computer Program for the Determination of an Optimal Advancement Policy for Petty Officers: A Dynamic Programming Approach, San Diego: U. S. Naval Personnel Research Activity, May 1966 (SRM 66-31).

[5]Silverman, J., Operations Guide for the ADSTAP System: An Integrated Computerized Enlisted Personnel Planning System, San Diego: Naval Personnel and Training Research Laboratory, October 1970.

[6]Ibid.

It should be noted that this report is not so much a description of research findings as it is a statement of progress and plans in the area of enlisted personnel planning research. Fundamentally, and in retrospect, the research has been designed to provide the tools necessary to answer three basic questions relating to personnel management. First, what did the Navy do yesterday? Second, what is the Navy doing today, and what are the implications? And third, what is the Navy likely to do tomorrow and what will be the effects? To answer these three questions for a Navy of over 500,000 personnel in numerous occupational specialties, various pay grades, and differential longevity, and undergoing constant change, is a complex and difficult task.

APPROACH

In research leading to the development of ADSTAP, there was a consistent philosophy; namely, the personnel planner is the core and most important part of the decision-making process. On the surface, this may not seem to be very controversial. However, in many applications of computer technology and operations research to personnel management, there is often an attempt to provide "optimal" solutions to extremely complex and highly constrained problems. To do so, the analyst centers his attention on technique rather than substance; that is, he tends to be concerned with the method of solution more than the nature of the problem. This fascination with "optimization" and other purely mathematical techniques often comes at the expense of understanding the managers' problem environment more completely and accurately. The result is frequently unfortunate for management, however it may advance the "state-of-the-art."

In the area of enlisted personnel planning, the entire research and development effort has focused on the problems of the personnel planner. Rather than employing resources to devise sophisticated mathematical techniques to "solve" problems "optimally" and automate the decision-making process, research culminating in ADSTAP has always had as its prime concern the nature of the personnel system itself; the constraints generated by higher level policy, administrative practice, and operational considerations; and the considerable problems of a decision maker surrounded by what must sometimes seem a totally chaotic environment.

This does not mean that advances in operations research and information technology have no impact on the development of decision systems. On the contrary, it simply indicates the necessity for care in the adaptation of such advances to specific problems and their environments. Even with this constraint, research in enlisted personnel planning has borrowed heavily from developments in computer technology and management science. In order to design a modern and responsive system of personnel planning it is impossible to ignore the speed at which computers can store and retrieve data, make calculations, and output information. This alone can provide decision makers with a personnel planning capability several orders greater than conventional methods afford.

Such a capability is enhanced by automated access to a much greater volume of relevant planning data, by improved forecasting techniques, and particularly, by the ability to generate alternative personnel planning strategies and measure the degree to which each alternative meets management objectives--all within a set of formidable operational constraints.

Basically, the approach in this research is to investigate advances in computer technology and management science for possible applications in the development of complex, large-scale, personnel planning decision systems. Such a system--ADSTAP--is intended to provide personnel planners with the tools and data necessary to make effective personnel management decisions, whether those decisions are involved in operational control or in policy determination.

The fact that some end products of this research have been implemented (e.g., ADPLAN and SPAN), are being used, and have improved the quality of decision-making, is evidence that this approach has been appropriate.

In the following sections of this report, the ADSTAP System and the problems it addresses will be described in terms of (a) the problems and processes of enlisted personnel planning, (b) the structure of the ADSTAP System, (c) its components, (d) its interface, and (e) future developments.

ENLISTED PERSONNEL PLANNING

Problems

Traditionally, numeric and qualitative stability in the Navy's personnel force, plus a sufficiency of manpower, made it possible for personnel planners to operate by "rules of thumb" and still project relatively accurate estimates of the future. In contrast, the increasing complexity of personnel flows through the system, the unstable nature of fleet personnel requirements, and continuing shortages of critical skills have significantly changed the work of personnel planners. The pace of technological advances, as manifested in radically altered or new hardware systems, has brought with it the requirement for more technical and highly trained personnel to man these systems. Problems in recruiting such personnel and the long lead times for training them have made the task of personnel planners more difficult.

Moreover, the necessity for operating within tight administrative and fiscal constraints has required more extensive quantitative, as well as qualitative, justification for ure of these resources. In planning to provide for sufficient personnel resources, the accuracy of such plans becomes extremely important. This is because the costs incurred by erroneous plans can be considerable. These are costs attributed to unfilled billets due to insufficient promotions or underprocurement, costs attributed to inadequate numbers of trained personnel or surfeits where they are not needed, costs attributed to idle facilities--in short, costs which are reflected in the lack of personnel readiness by operating units of the fleet.

The personnel planner is the recipient of a whole range of fundamental factors starting with the state of the economy (and therefore the labor market); national manpower policies as they affect the military services (such as conscription, Project 100,000 and Transition, or an all-volunteer force); international relations (as they affect the military personnel requirements); and the allocation of national resources. The last two factors have a special impact on the personnel planner. For instance, international conflict translates into national defense posture, naval military strategy, tactical objectives, fleet operational commitments, and finally, as specifications of the kinds and numbers of personnel needed to discharge those commitments (i.e., manpower requirements). National resources, on the other hand, are allocated to various public objectives via the budget, which in the case of defense ultimately translates into authorized strength. Manpower requirements and strength authorizations are sometimes at variance, especially when naval resources are reduced at the same time that new or extended naval commitments are established.

Underlying all of this is a dynamic process of shifting amounts of resources, shifting requirements, shifting authorizations, and shifting policies, plans, and priorities. In the "eye of the tornado" is the personnel planner who must make decisions which affect the ability of the Navy to meet its operational commitments--decisions made far in advance of the actual fact. The planner undergoes a continuous process of reducing raw data to planning information, evaluating alternatives in terms of constraints, making decisions, evaluating the results of those decisions against actual events, and finally, making renewed evaluations and decisions in a never-ending adaptive search for the "best" plans or policies. In recognition of the above, the ADSTAP development effort has consistently concentrated its attention on the problems of the personnel planner.

In summary, requirements for naval personnel, both as to number and type of skill, are undergoing continual changes in response to a number of factors. Some of these factors are external to the personnel system, such as continuing advances and shifts in the character of technology, changing world conditions, and the volume and variety of domestic programs of a social and economic nature. Other variables which exert a dynamic force on both manpower requirements and personnel resources are closer to the system; such as oscillations in the financial resources allotted to defense, the composition of manpower resources available to the military services, and a host of personnel programs and policies. Whether endogenous or exogenous to the system, these variables are reflected in continually changing requirements for naval officer and enlisted personnel, as well as changes in the resources available to meet those requirements.

In any event, it is clear that the effective managment of personnel resources has become an increasingly critical element of the Navy's ability to meet its operational commitments and achieve its long range objectives.

Processes

Personnel planning is associated with a variety of programs, plans, and policies, whose purpose is to initiate and control the flow of personnel through the system to ensure sufficient personnel resources in the various occupational specialties or ratings, in each pay grade of those ratings and at specific points in time.

There are four fundamental but interrelated tasks involved in enlisted personnel planning. First, planners are involved in establishing and maintaining personnel inventories which reflect the kinds and quantitites of personnel needed to accomplish a spectrum of naval missions. This process is controlled through a series of personnel plans involving the management of input (such as recruits and reserve volunteers), the control of internal inventory flows (such as promotions and continuance), and the management of certain kinds of losses. In addition, personnel planners must be concerned with other factors less subject to control--such as attrition, fixed inputs, and external constraints on the system.

Second, current inventories must be projected forward in order to determine the feasibility of meeting future needs. These needs may be short-term objectives reflecting operational commitments, and expressed in terms of (1) manpower requirements necessary to achieve a given level of operational readiness, and (2) budgetary limitations which represent a specified level of personnel cost. The objectives may also be long-range goals expressed by a set of force structure parameters, such as average time in service, promotion flow, career ratios, petty officer ratios, and other career development indicators.

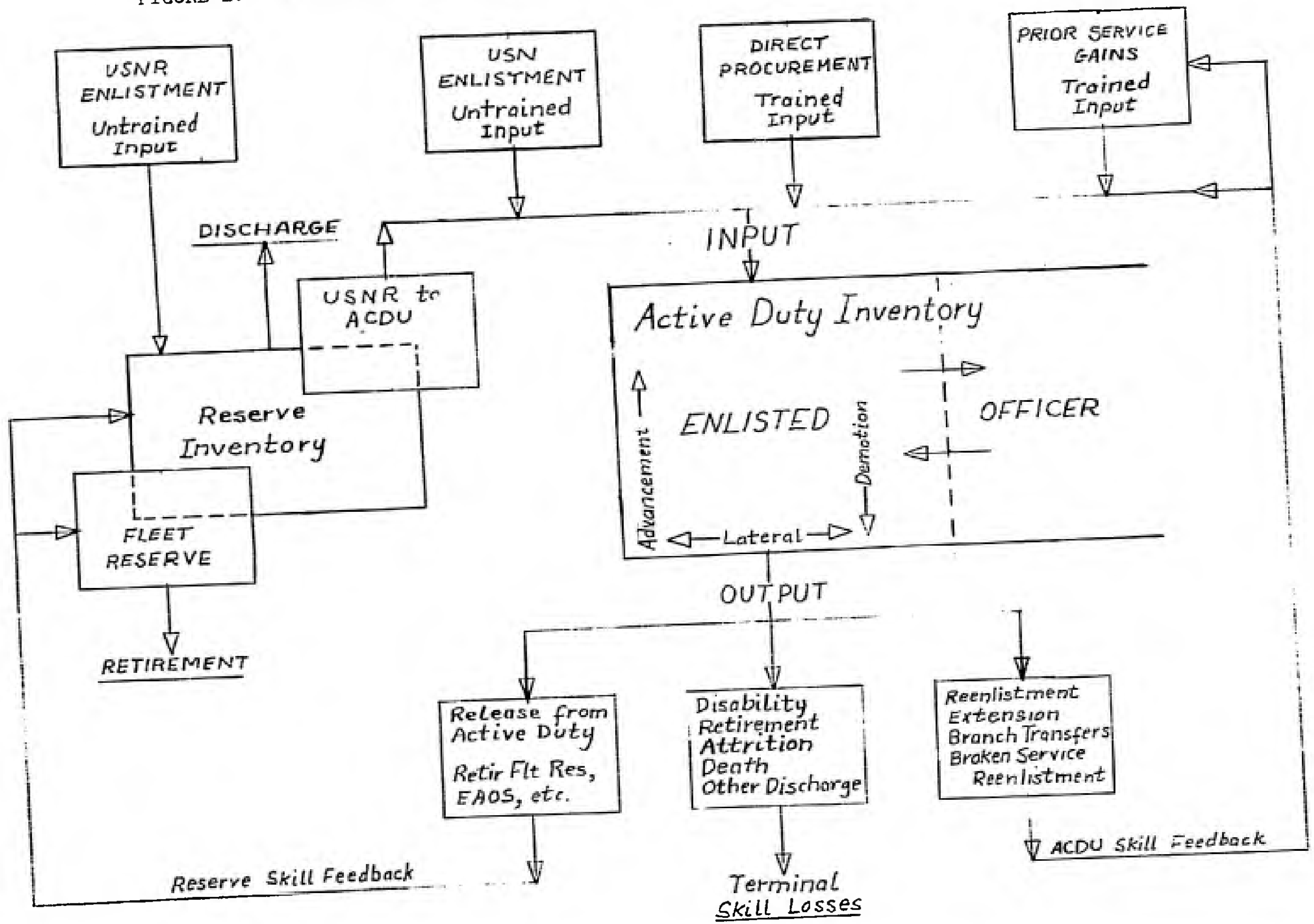
A third task involves comparing future requirements and predicted resources to determine areas of potential shortage or surplus. This is necessary to prevent or correct imbalances or deficiencies before they become critical--that is, before corrective action is either impossible or very costly. As a corollary to this, the personnel planner must have the capability of adjusting to rapid, unexpected, and externally-caused changes in fleet personnel needs or the available supply of manpower.

Fourth, the personnel planner is concerned with analyzing the projected effects of present and proposed personnel policies in order to evaluate their utility in achieving personnel objectives. Because of the size and complexity of the personnel system, and the costs involved in experimenting with a force of over 500,000 personnel, it is far more desirable to test the feasibility of changes in policy by programming those changes in a model which simulates the behavior of the personnel system. In this way, personnel planners can gauge the effect of current recruitment practices, proposed changes in promotion eligibility, training input schedules, severance policies, and a variety of other personnel programs affecting the quality and quantity of personnel inventories.

The size and scope of the personnel planning job itself is formidable. Figure 1 gives some idea of the input/output characteristics of the enlisted personnel system which the Navy's personnel planners must manage. In addition to the volume and variety of direct and indirect flows into, through, and out of the system, the planner must also account for these movements in terms of nine pay grades and some 100 occupational groups or ratings. It should be noted that input to the enlisted active duty inventory may consist of USN or USNR, trained or untrained, prior service or non-prior service personnel. Output may consist of terminal losses, feedback to the reserve inventory, or feedback to the active duty inventory. In addition, there are flows between enlisted and officer inventories and flows within the enlisted structure. Of the latter, upward movements are representd by advancements, downward by demotions, and sidewards by laterals (i.e., change of rating without change of pay grade). Any of these input-output flows or structural flows can be described in terms of pay grade, specialty or rating, and length of service or longevity.

Because of the enormous complexity of the system itself and the problems inherent in managing such a system under highly dynamic conditions, the Navy's personnel planners have focused their attention on the need for new and improved techniques of planning management and control. It is in response to this need that the ADSTAP research came into being.

FIGURE 1. INPUT/OUTPUT CHARACTERISTICS OF ENLISTED NAVAL PERSONNEL SYSTEM



STRUCTURE OF THE ADSTAP SYSTEM

The ADSTAP System functionally and logically integrates the objectives of enlisted strength, training, and advancement planning. In its final form, the system will enable personnel planners to accommodate rapidly to modifications in requirements, to identify significant problem areas, and to test alternative enlisted plans and policies prior to their establishment. ADSTAP will also provide the capability to generate relatively accurate projections of personnel strength for long-range planning purposes such as budget forecasting or policy planning. For short-range and mid-range enlisted personnel planning, the ADSTAP System will provide the capability of evaluating and controlling progress of current policies and programs.

Although the ADSTAP System is a fairly complex arrangement of massive data files and varied computer programs tied together in detailed inter-relationships, the basic structure of the system is relatively straight-forward. The system consists of three essential components: a Planning Data Base, a Projection Model, and a group of Planning Programs and Models.

These components operate in a series of input-output relationships reflecting the process of enlisted personnel planning. For instance, in the conventional personnel planning cycle shown in Figure 2 the Planning Data Base provides input to the Projection Model in the form of starting inventories and rates of change. The Projection Model acts on these inventories by calculating the major input-output flows in the personnel system, and producing a projection of the enlisted force, by size and composition, at specified times in the future. This output then becomes input for programs which produce plans for career development, enlisted advancement, strength management, training input, and personnel policy evaluation. The execution of such plans triggers recruitment, promotion, separation, and training actions throughout the system. These actions are consequently recorded by the personnel accounting system and become new input for the data base. ADSTAP is concerned most directly with the three processes encompassed by the dashed lines in Figure 2.

The several interrelated elements comprising the ADSTAP System are shown in Figure 3. The foundation is the Planning Data Base which contains both historic and current data. An historical Change Data Bank furnishes the raw material not only for the development of ADSTAP models and programs, but also for the development of rates of change which are applied in the Projection Model to predict variables affecting the force structure--such as attrition, retirement, and demotions. Inventory Files extracted from the most recent Enlisted Master Tape provide the starting personnel inventory for the Projection Model. These are tabulated for each rating in a pay grade and length of service table. Other data files such as the Advancement Exam Data Bank furnishes historical test taker and passer information. From this, rates are developed for the purpose of predicting advancement eligibles in the Projection Model for each rating and pay grade.

Another component, the Projection Model, calculates the major input-output flows in the personnel system to produce projections of the enlisted force by size and composition at specified times in the future--typically, at the end of a fiscal year. Gains and losses are computed

FIGURE 2. PERSONNEL PLANNING CYCLE

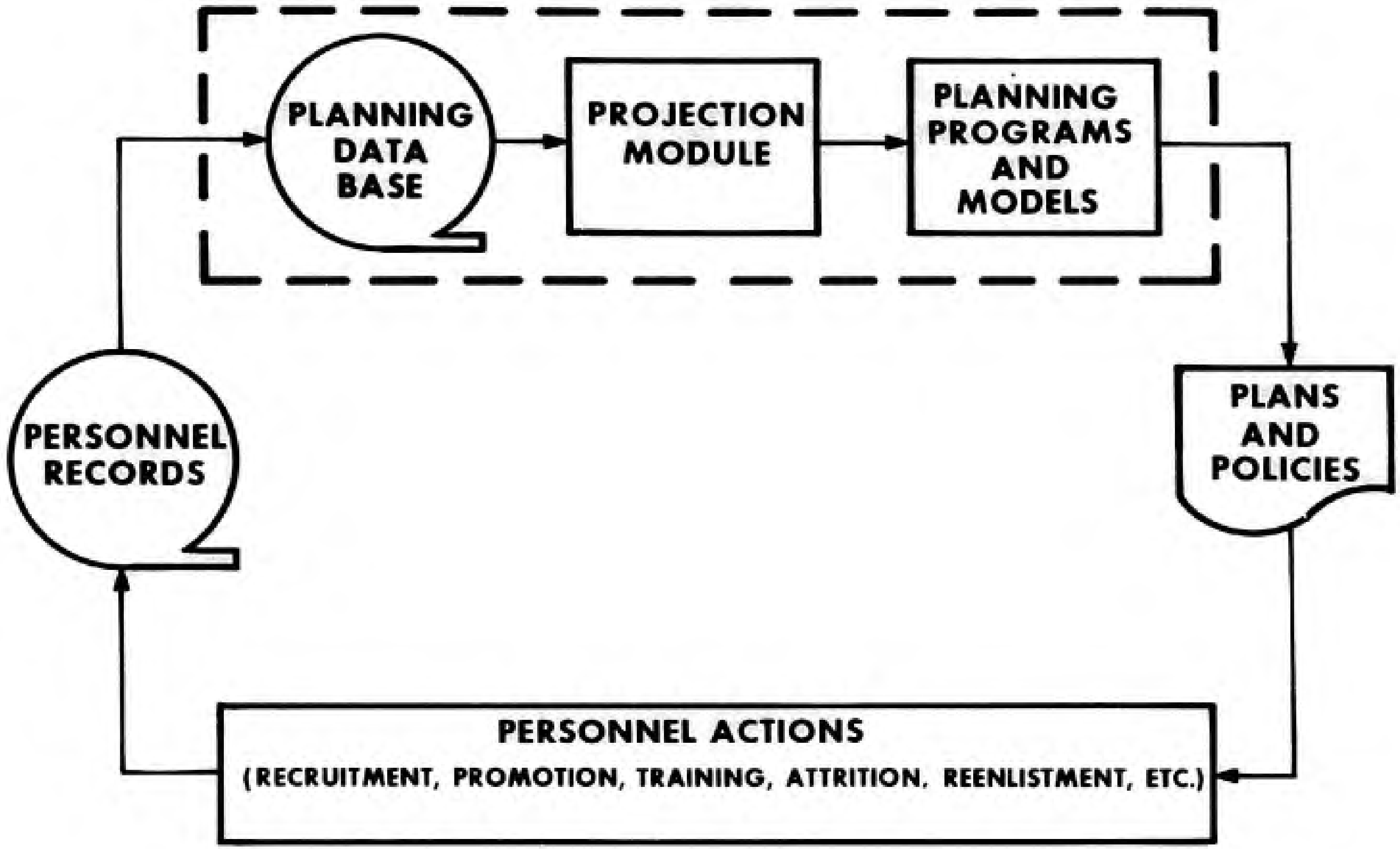
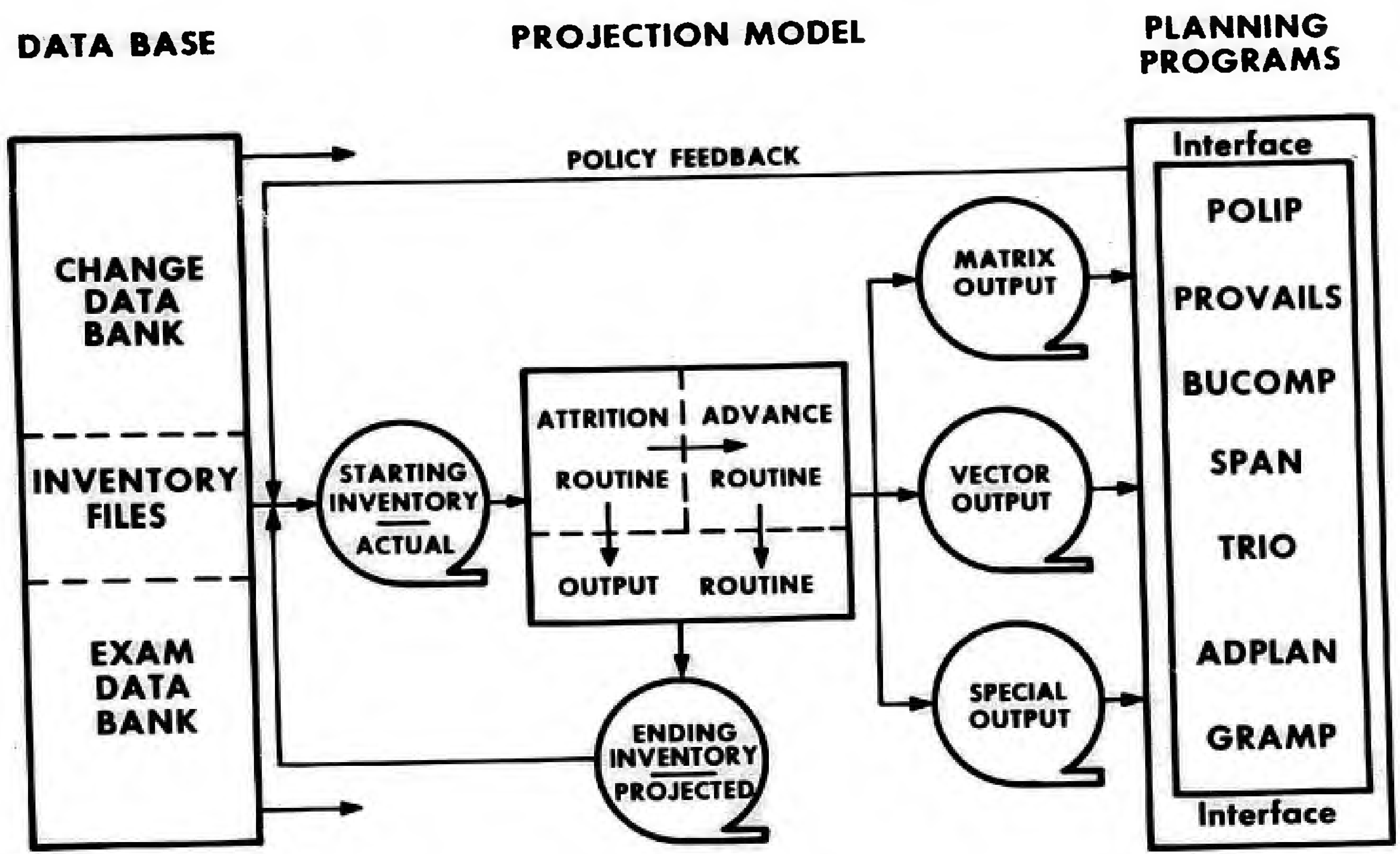


FIGURE 3. FRAMEWORK OF THE ADSTAP SYSTEM



and applied to each rating population. The resulting vacancies are then used to compute the advancements necessary to meet requirements. An output routine in the Projection Model processes this data for subsequent input to various computer programs used to assist in the development of specific plans.

The third component of the ADSTAP System encompasses a number of programs and computer models which operate in tandem with the Projection Model. A Policy Planning Program (POLIP) is designed to statistically measure the effects of various policies as they are reflected in certain force structure parameters such as career ratio, petty officer ratio, average time in service, etc. A Budget Costing Program (BUCOMP) computes personnel costs based on strength plan projections by applying approximately 40 different military cost factors. The Strength Planning Model (SPAN) is concerned with managing the enlisted force within budgetary (man-year average) constraints by means of rephasing recruit input and advancements, among many other things. One program still in the design stage (TRIO) is intended to optimize the allocation of recruits to the ratings, via A-school and on-the-job training, so that future rating requirements will be met. To assist in advancement planning, a computer model (ADPLAN) was designed to calculate petty officer advancements by rating and pay grade, and phase those advancements by month in order to meet the Navy's petty officer requirements within cost constraints. Yet another program (GRAMP) produces a set of data formats used by the Department of Defense in evaluating requests from the various services for personnel.

In succeeding sections of this report, each of the three basic components of the ADSTAP System shown in Figure 3 will be described in general terms. Future reports will treat these ADSTAP components in greater detail, and from a technical viewpoint.

PLANNING DATA BASE

Overview

Fundamentally, decisions are made on the basis of available information. This is so much the case that even the most wise and intellegent of men cannot effectively evaluate and decide on a given matter without information. By the same token, the most pedestrian decision maker can become extremely effective given sufficient information in the proper form at the right time. In understanding the enlisted personnel Planning Data Base, it is essential to recognize several features of management information.

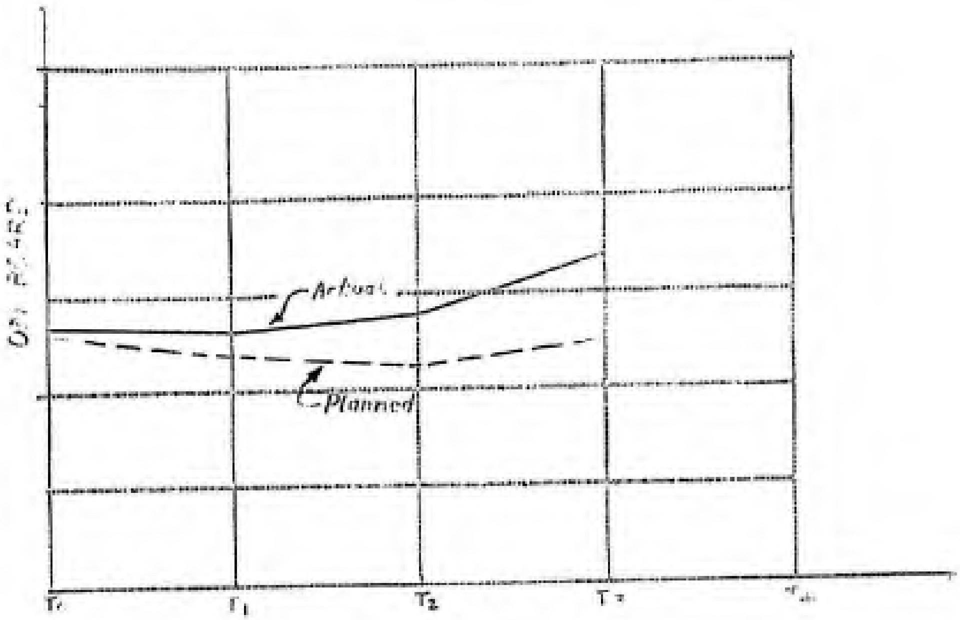
The volume of information is important. There should be adequate, but not excessive, amounts of data on which to base decisions, and additional data should be available on request. However, a floodtide of data dumped on the manager's desk should always be avoided--he will either ignore such massive volumes of information or conscientiously attempt to wade through it--and the result of the latter will be "information overload."

The form of data is likewise important. Too often data is presented to the manager in a form that requires a considerable amount of subsequent clerical effort to either decode or arrange in a simple, logical manner. In providing management information, it should be noted that the extent to which such information is used depends heavily on format or arrangement. Because formatting of data is accomplished so easily by the computer and is such a time-consuming task for the manager, the payoff in arranging data to maximize its utility for management is enormous.

Timeliness of information is also important if such information is to be used at all. In "tracking" the current operation of the personnel system to ensure consistency with plans and policy, the decision maker must possess up-to-date reports on the system. The longer the lead time in obtaining such information, the more constrained the decision maker is in choosing among alternatives. In the simple diagram shown below (Figure 4) one can visualize the problem of the personnel planner in regard to timeliness of information.

Suppose that a personnel plan is promulgated stating certain on board strength objectives at times T_1, T_2, and T_3. In addition, suppose that the "real world" is increasingly deviating from that plan. If the planner is aware of such deviation at T_1, he could conceivably adjust on board strength by taking relatively moderate action such as rephasing recruit input. If, however, the planner is not informed of such deviation until T_2--or worse, T_3--then the actions are likely to be more severe, such as an early release policy. In addition, the longer the lead time in obtaining current management information, the fewer are the options from which to choose.

FIGURE 4. PLANNING LEAD TIME



Along with the volume, form, and timeliness of management information is another characteristic that is even more important--the accuracy of information. There are situations in which having no information is better than having inaccurate information. In such instances, the decision maker must rely completely on intuition, and that is preferable to being led astray by erroneous data. In summary, management information is as essential to making decisions about the personnel system as combat information is in making tactical decisions.

In the ADSTAP System, the Planning Data Base is concentrated in several sizeable data banks. The term data bank refers to a large volume of data organized and indexed in such a way as to facilitate updating the file of data and extracting information from it. Data banks may consist of millions of individual records and various computer programs for storing and retrieving those records. Because the ADSTAP System is concerned with the past, present, and future management of a large and complex personnel system, the Planning Data Base underlying ADSTAP is considerable in both size and significance. In fact, it is a unique source of information on the historical operation of the naval enlisted personnel system. The following discussion centers on three particular data banks: two in the final stages of development and one currently in the design phase.

Inventory/Change Data Bank (INCH)

Like all management decision systems, ADSTAP is heavily dependent on information inputs. The most important single source of data support for ADSTAP is contained in the Inventory/Change Data Bank (INCH). In many ways, INCH is more essential than the computer programs and models which comprise the other components of the system. While personnel planning can exist without a Projection Model or a Budget Costing Program, it cannot function without information. In order to develop a personnel planning data base which could facilitate both model building and decision making, it was necessary to create a systematic reservoir of data that could be easily accessed and still remain comprehensive. Figure 5 shows the basic design of the processing system used to develop the ADSTAP Data Base, from receipt of the raw data to final output.

Encompassed within this Planning Data Base is an historical file of enlisted inventories (personnel on board) and changes to those inventories. The inventories are in the form of condensed Enlisted Master Tapes for the end/beginning of each fiscal year, namely 30 June, dating back to 1965 and available quarterly since July 1968. Complementing the inventory file is a comprehensive historical record of changes to the status of enlisted personnel over the last ten years. To date, this magnetic tape file contains records of some 25 million changes, including various kinds of gains and losses, reenlistments and extensions, demotions, lateral transfers, advancements, and many others. For this massive file to be most useful, a processing system was developed to update the files periodically in order to maintain their currency, as shown in Figure 6. Finally, a number of extraction, matricizing, and rate generation programs were designed to obtain the requisite volume of planning data, at a sufficient level of detail, and in the forms necessary for input to the planning system--as well as for research purposes. These processes are shown in Figure 7.

Upon completion of the documentation process, a forthcoming research report will provide greater detail on the operation of INCH and its contents. At present, the data bank is not yet in a form suitable for routine, operational inquiry by management.

Advancement Examination Data Bank (EXAMDAB)

One of the continuing problems in enlisted personnel planning research is the need to predict personnel resources eligible for promotion or advancement. Specifically, in order to project future on board populations by rating it is necessary to predict the number in each rating likely to be eligible and available to advance to the next higher pay grade of that rating. Given the Navy's advancement system, this problem boils down to the task of estimating service-wide advancement examination "test takers." Once this is done, the test takers provide the maximum number of "advancement eligibles." In order to obtain some idea of the probable number of "eligibles" it was necessary to develop historical information on the quantity of such resources for each rating and pay grade, and for each of the biannual advancement examinations.

FIGURE 5. BASIC DESIGN OF THE PLANNING DATA BASE

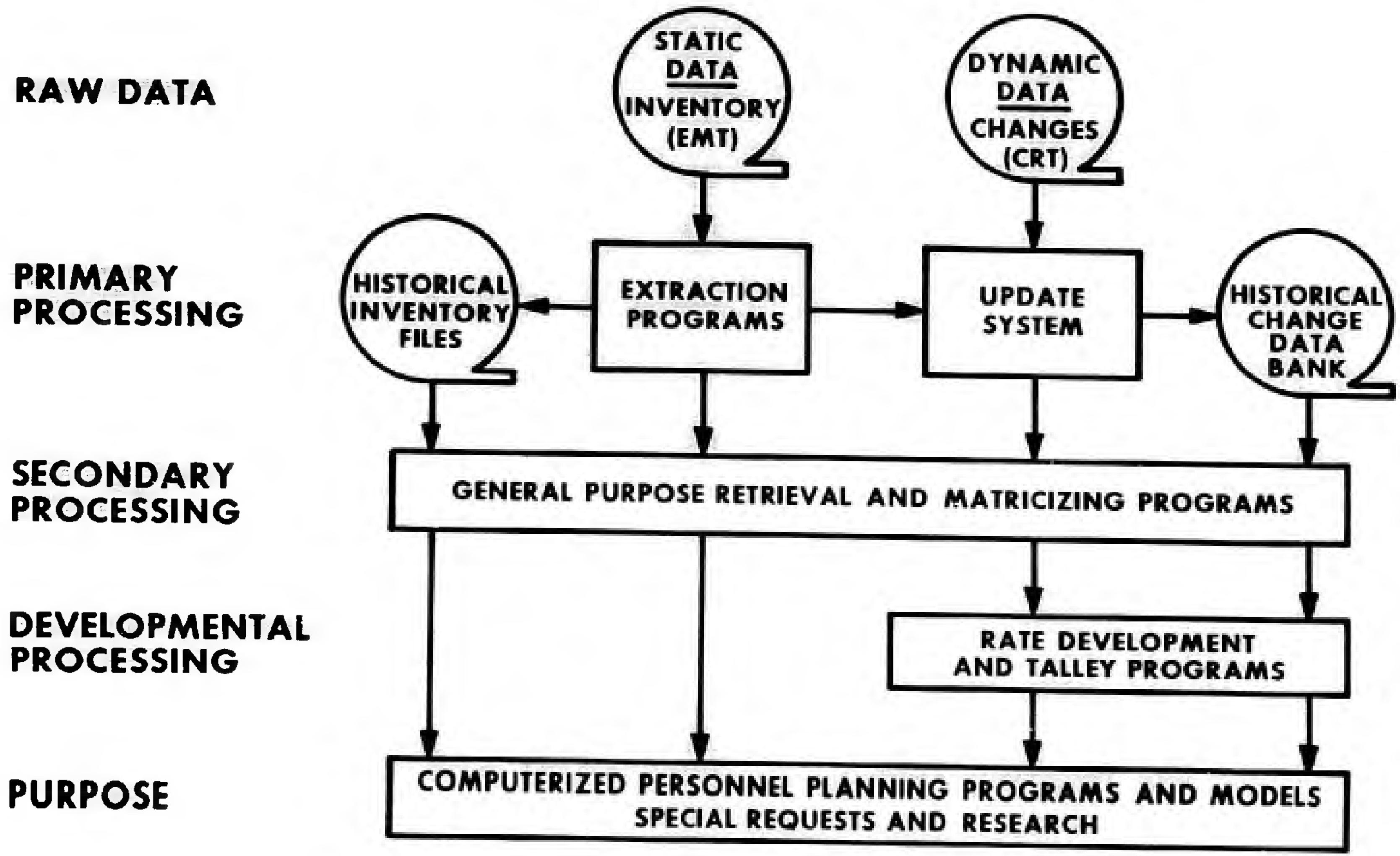


FIGURE 6. RAW DATA AND PRIMARY PROCESSING

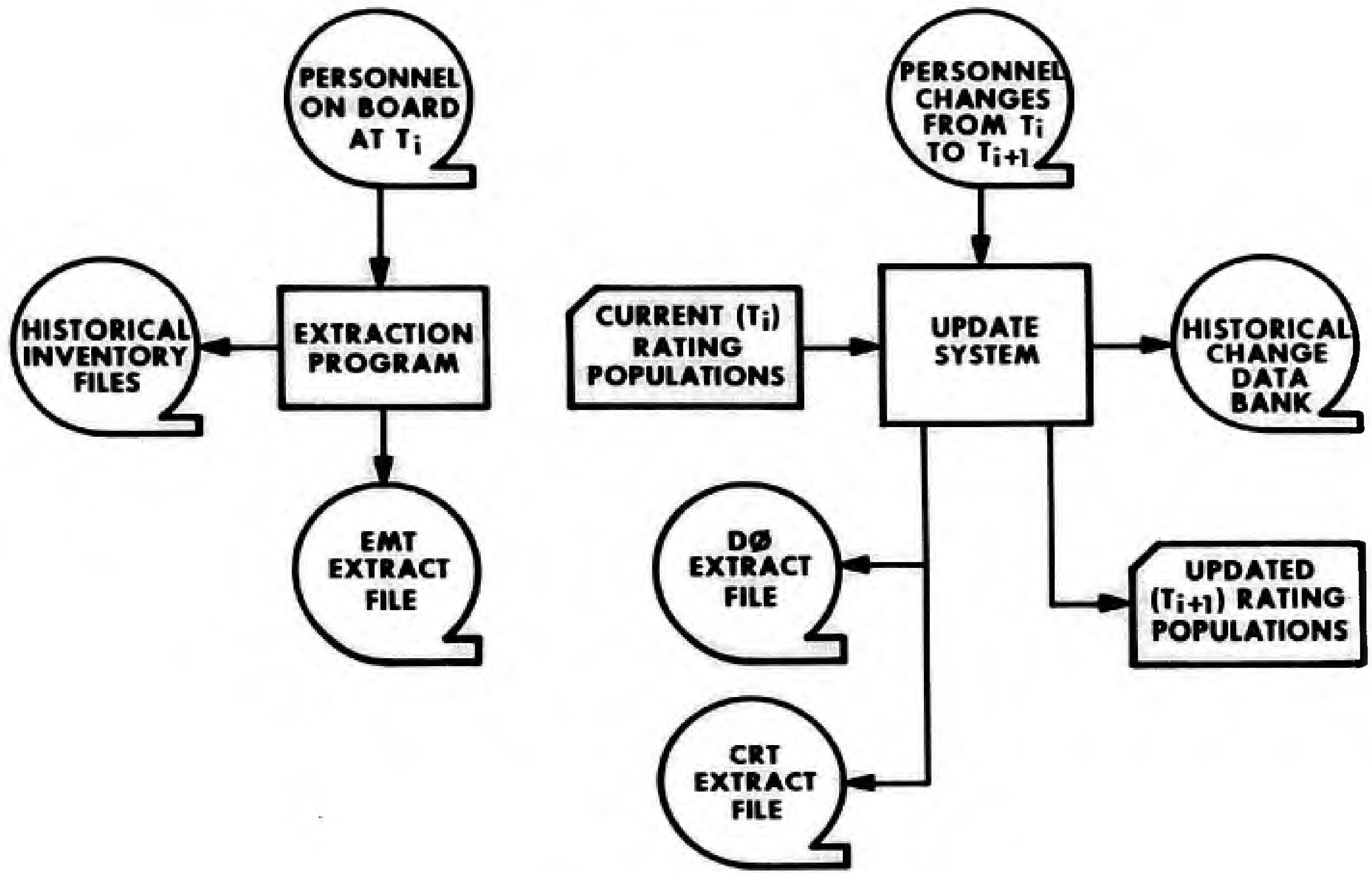
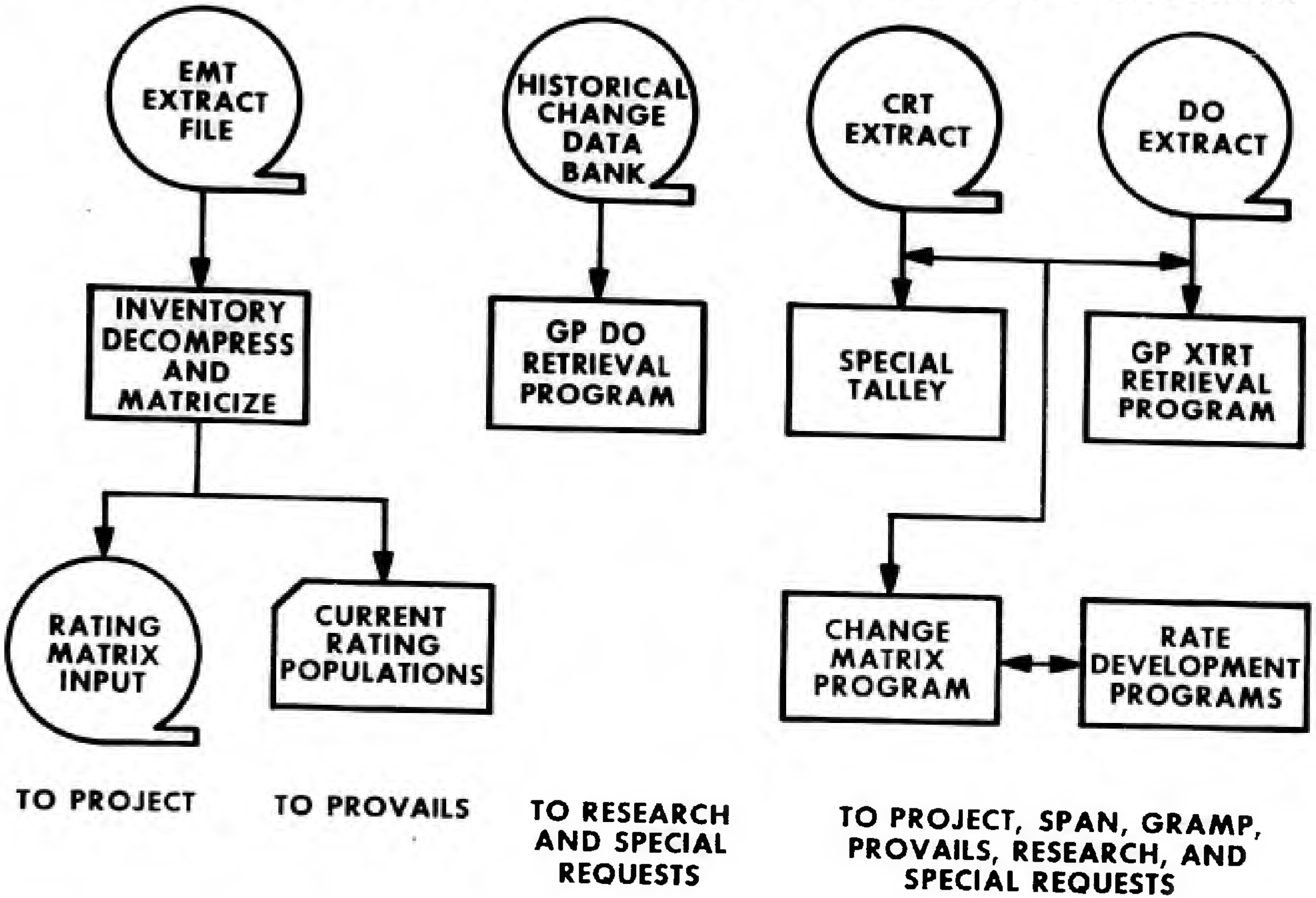


FIGURE 7. SECONDARY AND DEVELOPMENTAL PROCESSING



Accordingly, an Advancement Examination Data Bank (EXAMDAB) was designed and developed to provide this and other valuable information. Following each service-wide examination, the Naval Examining Center, Great Lakes, Illinois, provides the raw data to update EXAMDAB. Each exam's results are inserted in EXAMDAB by rate code, year and month in six month increments. This information is available for test takers, test passers, and advancers (or promotees). An update program is used to generate records from this data and then extract it in a number of different forms, as shown in Figure 8. Currently, EXAMDAB contains examination results from August 1964 through August 1970.

Working off of EXAMDAB is a series of programs which (1) display any or all of the data, by any sort, in the entire data bank; (2) compute the length of service (LOS) distribution within specified LOS limits for advancements, test passers, or test takers; and (3) compute the proportion of rating strength that the takers, passers, or advancers represent at each pay grade. Figure 8 illustrates the interrelationship among various programs in EXAMDAB, as well as the sequence of processing steps. EXAMDAB is currently being documented prior to the preparation of a technical report.

Advancement Candidate Data Bank (CANDAB)

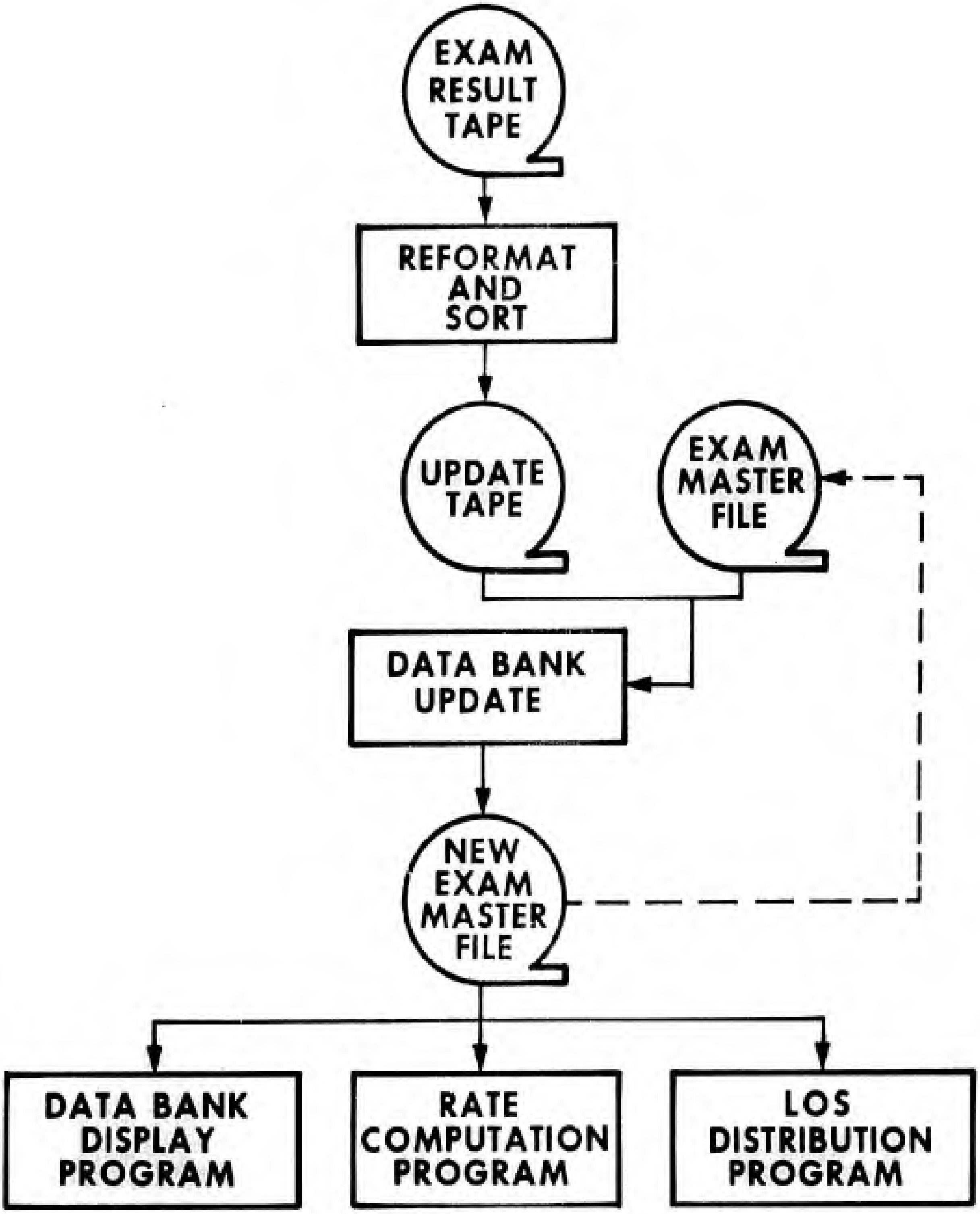
Coincident with research in enlisted advancement planning and the development of EXAMDAB, is another research effort devoted to the design of an Advancement Examination Candidate Data Bank (CANDAB). The purpose of CANDAB is manifold although the general intent is to develop information on a wide variety of variables affecting petty officer advancements. Raw data for CANDAB has also been provided by the Naval Examining Center in the form of a "Candidate Master File" on over 60 reels of magnetic tape. This data will be formatted and extracted to create the basic CANDAB file, and programs will be written to update and retrieve this data in various forms. Included in this file is the source rating of test takers, advancements by fleet, striker information on E-4 test takers, and length of service data, among many other data elements. This data provides a critical resource for further research and development in projection techniques, training input models, advancement planning research, and a number of other enlisted personnel planning research efforts.

Summary

The Planning Data Base described above serves a number of functions. First, it is the source of information on how the enlisted personnel system behaves. As such, it is absolutely essential in performing the research itself--there is, after all, nothing to analyze without data. This is particularly the case with INCH, which has provided the foundation for exploratory research and advanced development in the area of enlisted personnel planning.

As a fortuitous by-product of data base development, a wealth of information has become available for use by researchers and personnel planners. In fact, INCH constitutes the sole source for a whole range of unique historical data on the operation of the personnel system. Because of this,

FIGURE 8. ENLISTED ADVANCEMENT EXAMINATION DATA BANK SYSTEM



requests for and inquiries about historical data have increased significantly in the last year--the source of these requests emanating from internal Navy offices as well as contractors. Unfortunately, the Planning Data Base still lacks the documentation necessary for routine operational use by personnel managers.

In addition to its research and potential operational uses, the Planning Data Base is, of course, essential to the functioning of various models and computer programs. In the case of the ADSTAP System's Projection Model, for instance, requirements for a starting inventory, for historical gain and loss rates, for the probabilistic distribution of advancements over length of service, and for many other data requirements, places enormous demands on the Planning Data Base. To a lesser degree--but equally essential--other planning programs also rely on this data.

The way in which the Planning Data Base interacts with the Projection Model is discussed in more detail in the following section. Succeeding sections of this report will describe the nature of the interface between the Planning Data Base and computer programs for personnel planning and policy development.

PROJECTION MODELS

Overview

The ADSTAP System has been designed to operate in a process similar to that of the existing personnel planning system. It is expected, however, that ADSTAP will be more systematic, more comprehensive, and more responsive. Such improvements would be expected on the basis of computer power alone; but the application of management science to problems of personnel planning adds yet another dimension. Essentially, the contribution of management science to ADSTAP is in the area of system modelling. Decision making is significantly enhanced by the ability to project the effects of possible plans or policies using a model of the personnel system rather than experimenting on the system itself. In fact, when the system is large and complex, it is almost impossible to predict the detailed ramifications of alternative plans without the aid of a model.

Consciously or not, every planner has some concept of the way in which the system operates--and this conception is in itself a model of the system. By treating a greater number of variables more explicitly, and using the obvious capabilities of the computer, a formal, mathematical model of the system can become a good deal more powerful than a conception in the mind of the planner. By freeing the planner from information overload and onerous computational routine, a computer model enables the planner to use his capacity for judgement and evaluation--something the computer is lacking. In short, computer models enable the planner to operate at a higher level of analysis than is currently the case.

Because planning cannot be accomplished without reference to the future, a significant part of enlisted personnel planning research continues to be devoted to the development of new and improved forecasting techniques for use in personnel management. In this regard, some clarification of the terms "prediction," "projection," and "forecast" is warranted. Generally, a <u>prediction</u> is taken to mean an inference about a future event based on probability theory. Predictions are usually stated in terms of the likelihood of occurrence and the confidence that can be attributed to such likelihood. A prediction, for example, might state that in 90% of the cases the chance that a man in his 15th year of service will be lost through attrition is .03.

A <u>projection</u>, on the other hand, is an estimate of future possibilities based on current trends. As an example, a demographic projection might indicate that the average educational level of the population will increase two years for each decade into the future starting from 1970. Such a projection would be an extrapolation of an existing trend. A <u>forecast</u> is a more general term concerning a calculation, estimate, or "prediction" of some future happening or condition--usually as a result of rational analysis of data. For instance, the statement that "reenlistments for FY 1971 will be in excess of 40,000" can be termed a forecast.

Accordingly, although the heart of the ADSTAP System is referred to as the Enlisted Personnel Projection Model (PROJECT), the term "projection" should not be taken too seriously in this context. The model itself employs a variety of forecasting techniques; some probabilistic and some projective in nature. Basically, PROJECT is a computer program designed to forecast future on board populations by simulating the flow of personnel through the enlisted system. In addition, and because of a continuing interest in the area of forecasting, other techniques for estimating future conditions have been devised. However, because PROJECT is the central feature of ADSTAP, the description of these other techniques will necessarily be brief.

Enlisted Personnel Projection Model (PROJECT)

The idea behind personnel projection models is relatively simple, although the actual development of such models is frequently a good deal more complex. Basically, the ADSTAP Personnel Projection Model acts upon begin year inventories by computing the essential flows into, through, and out of the force of enlisted personnel, thereby, forecasting succeeding inventories of future years.

Before describing its operation, it should be noted that the basic unit processed in PROJECT is a personnel force structure or matrix. The latter is nothing more than a tally of on board personnel cast in the form of a pay grade by length of service (LOS) table, as shown in Figure 9. The terms "force structure" and "matrix" are used interchangeably. When such a matrix concerns on board personnel it is frequently referred to as an "inventory." It should be noted that different kinds of gains and losses, as well as advancements, can be cast in matrix form.

In PROJECT, all of the occupational groups or ratings, and most of the changes of those groups, are represented in this form. The length of service dimension affords a number of advantages. It is very useful in predicting many types of gains and losses which are not simply a function of on board strength or trends. Although it has value in forecasting gains and losses, it is absolutely essential in predicting the number of promotion or advancement eligibles based on minimum LOS requirements or accumulated minumum time in grade requirements. Only with the LOS dimension does it become possible to establish different minimum length of service requirements for advancement, and assess their impact on meeting manpower objectives for various pay grades and ratings. In a related way, LOS can be used to determine the effect of proposed loss management policies for retirement or "forced attrition" before they are instituted.

The length of service dimension also highlights the humps and valleys generated by buildups and drawdowns in previous years, and shows their probable effect on expected prior service gains, losses, and advancements. Without this, the Projection Model would not have the capability of determining promotion stagnation, its degree, and its effect on retention behavior.

By computing average LOS for the various pay grades and ratings, the Navy is provided with a tool to evaluate whether "rank means the same thing" between services, presently a concern of both DOD and Congress. It also enables the Navy to avoid "underaging" or "overaging" different pay grades and thus remain within the LOS guidelines established by higher

FIGURE 9. A FORCE STRUCTURE MATRIX

FY-1976

LOS	E1	E2	E3	E4	E5	E6	E7	E8	E9	TOTAL
0-1	24304	50871	23150	3123	134	0	0	0	0	101582
1-2	843	25508	64482	24452	2345	0	0	0	0	117630
2-3	483	6110	34650	37867	14483	0	0	0	0	93593
3-4	676	2350	15479	22469	25873	0	0	0	0	66847
4-5	281	501	4746	3161	8718	2197	0	0	0	19604
5-6	0	724	1887	1868	6385	3954	0	0	0	14818
6-7	0	0	1459	2118	4509	5677	0	0	0	13761
7-8	0	0	1119	1990	3968	6805	0	0	0	13882
8-9	0	0	430	1402	3947	5923	1178	0	0	12880
9-10	0	0	1741	1949	3973	6259	1677	0	0	15599
10-11	0	0	0	1318	2097	5587	2353	0	0	11355
11-12	0	0	0	1056	3042	5042	2861	0	0	12001
12-13	0	0	0	884	2519	4768	2646	476	0	11293
13-14	0	0	0	758	2376	4094	2959	258	0	10445
14-15	0	0	0	615	2616	4176	2916	353	89	10766
15-16	0	0	0	526	2355	4426	2670	571	144	10692
16-17	0	0	0	433	2130	4193	2701	761	213	10431
17-18	0	0	0	360	1825	3429	2878	789	214	9495
18-19	0	0	0	227	1685	3516	3259	889	283	9859
19-20	0	0	0	217	1718	3945	3265	971	383	10499
20-21	0	0	0	331	916	2173	2252	701	298	6671
21-22	0	0	0	0	397	937	1348	558	255	3495
22-23	0	0	0	0	232	569	939	460	217	2417
23-24	0	0	0	0	159	457	738	415	191	1960
24-25	0	0	0	0	104	203	390	327	188	1212
25-26	0	0	0	0	257	119	273	254	169	1072
26-27	0	0	0	0	0	463	236	243	148	1090
27-28	0	0	0	0	0	0	212	216	139	587
28-29	0	0	0	0	0	0	187	166	116	469
29-30	0	0	0	0	0	0	173	166	120	459
30+	0	0	0	0	0	0	169	133	164	466
TOTAL	26587	86064	149143	107123	98763	78912	38280	8707	3331	596910

authority. In short, the length of service matrix provides a tool to evaluate whether proposed career development or force renewal objectives--whether stated in terms of career ratios, average LOS, or any other parameters--are feasible of attainment.

Probably one of the greatest benefits derived from a model which forecasts length of service distributions is in the area of personnel costing and manpower budget planning. Because enlisted pay is based largely on the combination of grade and longevity, the ability to forecast the LOS distribution of future enlisted inventories is essential in estimating the future manpower budget--of which pay and allowances represents 70% or more.

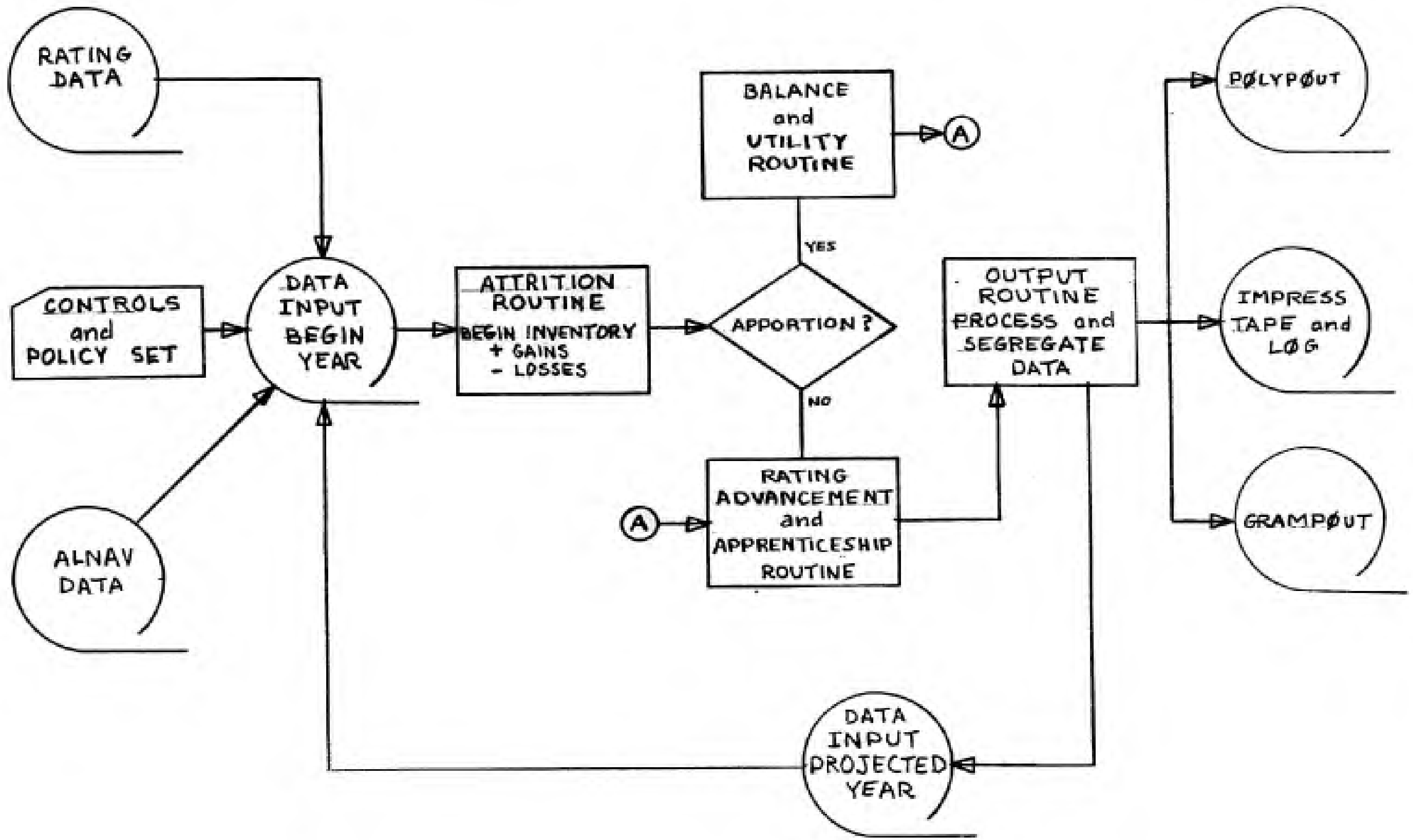
In order to process length of service inventory matrices, the Projection Model operates under the direction of control cards and various data inputs. Basically, the control cards establish the date of the starting inventory and the number of years to forecast. They also exercise a series of options concerning the computation of losses, iteration capabilities, and advancement alternatives. Other inputs are concerned with data itself--such as begin inventories, fixed gains, change rates, advancement examination rates, and requirements. Finally, there are special controls which establish the structure of career ladders; the number, form, and location of outputs; and which specify the "aging" of the population. All of the data that is input to PROJECT is concentrated in one of two sources: ALNAV or RATING data sets. These terms, although not fully descriptive of their contents, represent data tapes required to run the Projection Model. ALNAV input consists of the various controls noted above as well as certain data elements used in computing gains, losses, and continuance; RATING input contains data required to process advancements.

Basically, the architecture of the Projection Model provides for linkages among three major routines: Attrition, Advancement, and Output as shown in Figure 10. In the Attrition Routine, the Model computes predicted gains and losses to the beginning inventory and calculates the number of recruits necessary to fill total Navy vacancies. Gains and losses computed in the Attrition Routine are then applied to the various ratings in the Advancement Routine. In the latter, the Model computes vacancies for each rating, the advancements required to fill such vacancies, and the predicted number of personnel eligible (on the basis of service-wide exams) to advance. Advancements are then applied to the inventory and the matrix is aged--that is, all personnel are moved up one year of service or some fraction thereof. This process completes one year of projection for each rating. The Output Routine processes both the input and computational results in various forms for different planning purposes, and employs the forecast of the first year as input for the next year of projection. Computationally, the three major routines in the Model operate and interact as follows.

1. Attrition Routine

The Attrition Routine determines the losses, gains, continuance, and new input for the total Navy. There are six different kinds of losses predicted by the Model. Five of the losses--Expiration of Enlistment, Attrition, Retirement, Desertion, and USNR Separations--are considered terminal because they are true losses to the force of active duty enlisted personnel. It should be noted that although most deserters are later

FIGURE 10. INPUT/OUTPUT SYSTEM FOR PROJECTION MODEL



treated as a gain, when captured or surrendered, they are considered terminal at the time they are lost to the force. Demotions, the sixth type, is considered a structural loss because the loss is to a pay grade, not to the active duty force. All losses are predicted for each of nine pay grades and each of 31 length of service categories.

The procedures used to compute the different kinds of gains vary according to their use in the Model. Some prior service gains are predicted as a single number from the base inventory, and then distributed by pay grade and length of service. Others are predetermined as a matter of policy or predicted by using a rate matrix similar to that of losses. There are six kinds of prior service gains computed in PROJECT: Continuous Service Reenlistment (2-90 days), Broken Service Reenlistment (over 90 days), Deserters Returned, USNR Volunteers (2 x 6), USN Miscellaneous Gains (other service transfers, intra-Navy transfers, etc.), and USNR Miscellaneous Gains (4 x 10, intra-Navy transfers, etc.). Demotions, although a structural gain, are also treated by the Model as a prior service gain. All of the latter gains are calculated in matrix form (i.e., 9 x 31). These gains, as well as the losses calculated previously, are applied to the begin population in order to produce a net inventory. In addition, prior service gains are "saved" for use in the Advancement Routine.

Non-prior service gains, excepting USN Recruits, are fixed numbers reflecting a predetermined level of input. In order to determine recruit input, the net inventory is summed into a pay grade vector (E-1 to E-9) and then subtracted from end year requirements. The differences at each pay grade, when summed algebraically, represent total Navy vacancies. This figure constitutes the new input necessary to bring the force up to strength in the projected year. When non-prior service gains (such as Waves and Filipinos) are subtracted from the new input, the remainder represents recruit input. Total new input, like other gains, is saved for use in the Advancement Routine of the Model. However, unlike prior service gains, new input will only appear in the first cell of the force structure matrix; i.e., those with less than one year of service.

Although PROJECT is "driven" by gains and losses to the force, the Model predicts various forms of "continuance" as an information by-product. Included in this category are reenlistments, extensions, and USNR to USN transfers. Having computed gains, losses, and continuance in the Attrition Routine, the model then begins to simulate the enlisted promotion (or advancement) process on a rating-by-rating basis.

2. Advancement Routine

The advancement methodology, by which enlisted personnel are promoted from pay grade to pay grade, is the heart of the Projection Model. The computation of advancements for pay grades E-1 to E-3 differs from that used in the case of E-4 to E-9. This is because the petty officer pay grades represent rating resources most directly, and promotion within ratings is based on service-wide advancement examinations. In contrast, promotion from E-1 to E-3 occurs rapidly and is not grounded in the specialized requirements of different ratings.

The Advancement Routine processes each rating separately because of the large volume of input that must be maintained in core memory at one time. First, a rating inventory matrix is read from the RATING data set and a net inventory is computed by adding prior service gains to and subtracting losses from that beginning inventory. Rating losses are some portion of the total losses calculated in the Attrition Routine, and distributed to each rating using "loss distribution rates" contained in the RATING data set. At the option of the planner, gains are proportioned to each rating based on the population of that rating relative to the total Navy or by historical rates.

After applying predicted gains and losses, the resultant net inventory is subtracted from requirements--the difference representing rating vacancies. Advancements required at each pay grade of a rating are determined by cumulatively adding vacancies at one pay grade to advancements required at the next higher pay grade--starting at E-9 and carrying down to E-4. This process ensures that vacancies resulting from promotions out of a pay grade will be counted just as much as vacancies resulting from losses.

Advancement eligibles are then computed by test taker and test passer rates which predict the number of personnel, by rating and pay grade, who are likely to take and pass the service-wide advancement examinations. Eligibles are compared with advancements required at each pay grade, and the lesser number is advanced. The advancement methodology limits promotions to either the number needed to fill vacancies or the number of personnel eligible to advance, depending on which is smaller. In this way, the personnel planner can determine what kind of personnel force structure is feasible in terms of the constraints built into the system. Figure 11 provides a hypothetical example of the computational procedures employed in the Advancement Methodology.

The end strength for each rating is determined by adding the advancements into each pay grade and subtracting them from the next lower pay grade. In the case where several occupational groups combine into a more general rating, advancements are made by rating structure group.

Rating structure groups represent a family of jobs or related occupations which provide an arena for career progression through the entire range of pay grades. Because of the existence of career ladders, the calculation of test passers, advancements required, and actual advancements must take into account the various kinds of branching among ratings. The Projection Model accomplishes this through a generalized routine which handles branching or "splits" up or down at any pay grade level.

After advancements are calculated for each pay grade, they are distributed by length of service using a random number generator as constrained by historical distributions. These are then applied to each rating's net inventory. Subsequently, the rating matrix is aged; that is, all personnel in each cell of the matrix are moved up one year of service or some fraction thereof. This aged matrix is written on the output tape and becomes the start inventory for the next year of projection.

FIGURE 11. ADVANCEMENT METHODOLOGY

Pay Grade	(a) Net Strength	(b) Require-ments	(c) Vacancies [b-a]	(d) Advance Required $[c_i+d_{i+1}]$	(e) Test Passers	(f) Advance In [<d,e]
9	90	100	10	10	15	10
8	180	200	20	30	40	30
7	360	400	40	70	65	65
6	600	700	100	170	150	150
5	1700	2000	300	470	550	470
4	2400	3000	600	1070	870	870
TOTAL	5330	6400	1070	1820	1690	1595

3. Output Routine

The last component of the Projection Model is the Output Routine. By making this a separate sub-routine the Model user has greater flexibility in controlling the output of the Model. Personnel planners may dictate the volume, form, and location of over 75 items of information contained in an "output table". The Model produces three output media: First, a GRAMPOUT tape which contains projection data necessary to produce the semi-annual Grade Management and Career Development report; second, a POLIPOUT tape which contains all of the data generated in the Model--this tape is the source of input to all of the planning programs and models in the ADSTAP System; and third, IMPRESS output in the form of a listing. The latter contains the results of any calculation performed in the Model, as well as various data inputs, as dictated by the Model user. Part of the flexibility of the Output Routine is due to the fact that information necessary to evaluate various types of policy alternatives can be specified item by item.

As an adjunct to PROJECT, a special program interfaces Projection Model output (i.e., POLIPOUT) with the various planning models and programs in the ADSTAP System. This program, written to eliminate off-line processing, is called the Projection Output Disseminator (PROD) and contains features which allow for the dynamic allocation of arrays and variable output controls.

4. Applications

The Enlisted Personnel Projection Model (PROJECT) has a wide range of applications in the evaluation of personnel policies and in the generation of planning data. Some of these capabilities are listed below.

a. Generates forecasts of on board strength by rating, pay grade, and length of service for a theoretically unlimited number of years.

b. Projects force structure configurations and reflects the effects of humps and valleys in the longevity structure for each rating and pay grade.

c. Predicts and computes ten types of gains (including Recruits, Continuous Service Reenlistment, Reserve Input, Demotions In, etc.); six kinds of losses (including USN Expiration of Enlistment, Desertion, Retirement, Attrition, USNR Separations, and Demotions Out); and several varieties of continuance (including reenlistment, extension, USNR transfers to USN, etc.). These variables are predicted by service longevity up to 31 years, by each pay grade, and for any number of fiscal years into the future. For each rating and pay grade, and for each fiscal year, the Model also predicts total losses, total gains, vacancies, advancements required, test takers, test passers, and advancements in and out. In addition, other information is produced to reflect Model input and to provide measures of Model performance.

d. The Model outputs a "LOG" which contains all information concerning the processing of individual ratings by pay grade (the LOS dimension is omitted in the LOG). This enables the user to determine at a glance exactly how the rating was treated in the Model; whether it failed to meet requirements or exceeded them, the degree of shortage or surplus, and the reasons for the situation.

e. To accommodate management information inputs, the Model can introduce "known" numbers (such as Filipino, Wave, and 2 x 6 input) for any variable and for each of five years.

f. In order to introduce the effect of early release programs, the Model can override the prediction of "normal" losses by increasing the number of losses, and automatically shifting the longevity cell from which those losses derive.

g. By projecting future force structures based on various constraints and policy sets, the Model can test the feasibility of a number of policies and manpower objectives; including requirements, petty officer strength, rating advancements, recruit input, promotion opportunity, separation policy, career ratios, experience levels as measured by mean LOS, longevity configuration, retention objectives as reflected in loss behavior, automatic advancement policy, and others.

h. The Model can compute advancement "apportionment" by iterating each year of projection in order to perform comprehensive balancing operations.

i. One of the critical features of the Projection Model is the flexibility and power of its output routine: it has the capability of producing any or all of more than 75 variables by any or all ratings, by pay grade, by length of service, and for each year of projection. It is completely directed by the user, who can employ output controls as selectively or liberally as desired.

j. Most important, the Model was designed to generate a comprehensive data base equally useful for strength/budget planning, advancement planning, establishing training input quotas, recruit and retirement plans, grade management and career development analysis and reporting, as well as special studies.

The preceding discussion was not intended to be a comprehensive statement of the Model's capabilities but rather a general overview so that the reader can better understand the importance of the Projection Model in the total ADSTAP System. For a description of the mathematical and computer-oriented properties of the Projection Model, a technical report will subsequently be written.

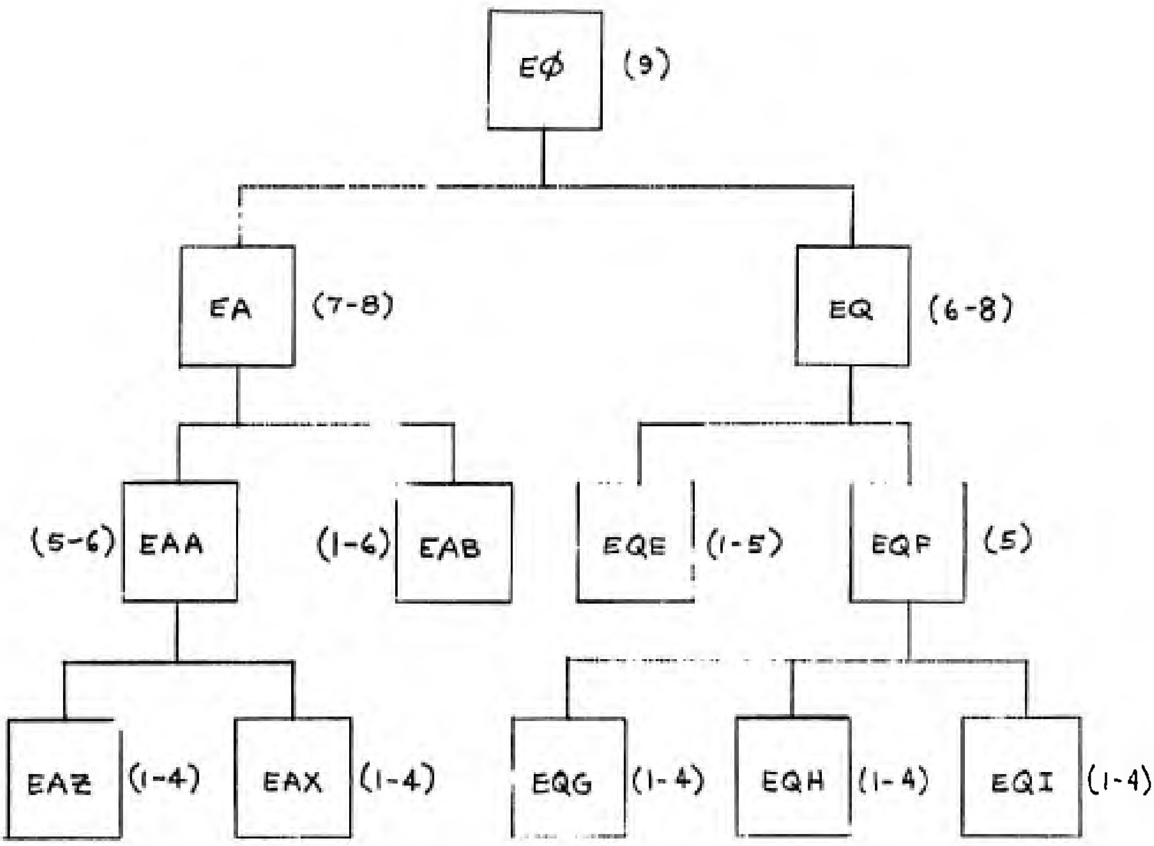
Advanced Enlisted Personnel Projection Model (AEPP)

Although the Model described above constitutes a respectable "simulation" of the enlisted personnel system, an "advanced" Projection Model is under consideration and there are a number of refinements to the present Model undergoing research. Planned state-of-the-art developments in forecasting methodology envision both programmatic and methodological advances. Some of the structural objectives embraced by the design philosophy of an Advanced Enlisted Personnel Projection Model (AEPP) are discussed below:

Such a Model should have flexibility to the extent that a personnel structure of virtually any complexity could be represented internally. Among the required attributes are the ability to process any number of ratings, each having a set of any number of pay grades, such that individuals can be identified by an unique ordered pair (rating, pay grade). Within each such ordered pair, personnel would be further classified by length of service. In this scheme, progression in length of service is accomplished internally, by time base; progression from ordered pair to ordered pair is permitted across any rating boundaries; and flexibility exists for defining multi-pay grade advancement paths. As a result, a rating structure group may contain a multitude of branches with complete flexibility as to career path.

To illustrate the Generalized Branching Methodology discussed above, Figure 12 shows a completely hypothetical rating structure group.

FIGURE 12. A HYPOTHETICAL CASE OF GENERALIZED BRANCHING



To specify the form of the rating structure group shown above, the following code might apply:

```
CN * (EØ(9) : (EA(7-8) : (EAA(5-6) : (EAZ(1-4), EAX(1-4)),
     EAB(1-6)), EQ(6-8) : (EQE(1-5), EQF(5) : (EQG(1-4),
     EQH(1-4), EQI(1-4)))))
```

Whatever the specific methodology finally developed, the concept of "generalized branching" is well worth pursuing in the context of an Advanced Projection Model.

In addition to the above, such a Model should provide for the specification of lateral movement (i.e., rating-to-rating with no change in pay grade). Constraints on the "movement" of individuals from one ordered pair to another can be permitted in a variety of ways, from a single general rule to a level of detail which allows an entirely different technique for each path in the system. Also, the model should permit structural changes on any time-interval boundary--the intervals of time themselves being variable in units of months.

There are other features that should be included in AEPP. Most input to the Model, with the exception of large tables, etc., should be in a free-form, problem-oriented language in order to reduce program set-up time and increase comprehensibility of the input. Extensive diagnostic capabilities should be provided to permit visibility at any level of detail in dealing with "troublesome" flows.

Data management facilities should exist which allow the program to access the personnel structure efficiently within a wide range of core sizes. This could be accomplished by using a direct-access file to provide apparent core residency of the entire file. Likewise, in consideration of the need for minimizing core storage requirements, the program should be carefully structured to make efficient use of a multi-region overlay structure.

Aside from the major research effort that would be required in the development of AEPP, there are a number of refined and new methodologies intended to considerably enhance the capability of the existing Projection Model (PROJECT). However, because of the current size and complexity of PROJECT, some of these enhancements may not be introduced until the advent of AEPP.

1. <u>Direct Rating Gains</u>

At present the Projection Model cannot input non-prior service gains <u>directly</u> to petty officer pay grades. In the case of direct procurement and USNR 2 x 6 input to ratings--and to some extent, Recruits--the Model should be able to gain such personnel to petty officer status without flowing them through the non-rated base. Methodology to encompass such flows has been developed and awaits programming.

2. <u>Reserve Flow</u>

The Model presently treats the enlisted force as a single branch of service, although some gains and losses are predicted by USN and USNR. It is desirable to carry two inventories, at least initially, in order to improve the forecasting accuracy--especially that of USNR populations. Data analysis has been initiated to evaluate the feasibility of such an approach.

3. <u>Lateral Movements</u>

The Model at present does not account for lateral flows between ratings. To remedy this, research is underway to measure inter-rating flows by pay grade over time and design a methodology to simulate these movements in the Projection Model.

4. Loss Management

This is the most neglected area of personnel management research because losses to the force are often considered to be beyond managerial disposition. Although losses may not be completely controlled, they can definitely be managed--especially if the problem of losses/retention is approached strategically. Policy testing methodologies are being developed to account for involuntary extension and early release policies so that the Model user may determine the short-run and long-range effects of loss management strategies. Some methodologies can become extremely complex because they must cope with somewhat unpredictable shifts in length of service configuration.

5. Advancement Eligibility

Although the Model currently computes eligibility for petty officer advancement by predicting test takers and test passers, as well as automatic advancements, the predictors used to determine eligibles by pay grade are subject to wide variability. Using information from the Advancement Examination Candidate Data Bank (CANDAB), length of service distributions for test takers will be developed and such eligibility matrices should provide a much better basis for prediction. Given such matrices, it is then possible to test minimum length of service policies for advancement eligibility. In addition, a methodology will be developed for predicting advancement eligibles by zone and waivers from zone. Thus, policy planners will be able to set the percent waived as well as the number of years of service from either extreme of the promotion zone that are eligible to be waived.

6. Dynamic Advancement Methodology

One of the great difficulties in simulating petty officer advancements is determining the length of service (LOS) distribution of those advancements by rating and pay grade. The problem centers on the need to avoid the subtraction of advancements from LOS cells with insufficient populations, thus generating negative numbers. At the same time, advancements into a pay grade must be somewhat "younger" than the pay grade vector itself--although this differs by rating. This is a very delicate problem of matching three different LOS configurations: the population in the "from" pay grade, the advancement population, and the population in the "to" pay grade. A mathematical solution to this problem has been developed and awaits programming and subsequent test/evaluation.

7. Source Rating

This problem is associated with rating families in which advancements required for a given pay grade are identified, but the source ratings in which advancement eligibles originate are not identified. Currently, the Model distributes advancement eligibles to source ratings based on population proportion. At such time as CANDAB is completed, information will be available to develop better predictors of source rating variabilitiy.

8. Non-Rated/Striker Flow

A major research effort has been initiated for the purpose of simulating flows in the lower three pay grades. This is an extremely difficult task because the flow across pay grades is so swift; because of the "turbulence" in the lower or "younger" length of service categories; because many personnel in those pay grades are not identified by rating; because of the differential routes to petty officer status via A-school vice on-the-job training; because of the massive lateral movements among apprenticeship groups; and because of the methodological problems associated with techniques for allocating recruit resources and controlling longevity distributions. Nevertheless, a start has been made in this direction with a design effort for a "bottom three" simulation model called LOFLOW. This is discussed in another context in the section describing Recruit Allocation and Training Input Models.

9. Retention Methodology

Currently, the Model is "driven" by losses to the force structure--thereby predicting vacancies, simulating advancements and generating projected inventories. The quantity of personnel who are not lost to the service are, by definition, retained. In the present version, there is no distinction as to whether personnel are retained by reenlistment, extension, or simply "aging." Research is intended to develop a methodology which can run the Model "backwards." That is, the Model will predict or accept predetermined levels of retention, and those personnel not retained will be considered lost to the service. In this way, the Projection Model can be used to directly test retention policy by rating and determine the out-year effect of such policies.

The future developments planned for the Projection Model might make it appear that the present version is somewhat lacking. In actuality, as noted previously, the current Model is relatively accurate and extremely powerful in terms of both policy testing and generating a planning data base. But, as in all aspects of the ADSTAP System research, a continuing effort is being made to broaden the underlying methodology and expand the potential applications of the Projection Model to meet the ever increasing needs of the personnel planner.

As noted at the beginning of this section on Projection Models, a brief description of other forecasting techniques was promised. The following paragraphs discuss two other computer programs currently under development.

Monthly On Board Forecast Program (PROVAILS)

Although the ADSTAP System's Projection Model generates projections of on board strength by rating by year and the Strength Planning Model (SPAN) generates projections of on board strength total Navy by month, there is no effective computerized tool for predicting on board strength by rating by month. The need for such a program lies with the interface between personnel distribution and assignment subsystems and personnel strength, advancement, and training subsystems.

In order for managers to assign enlisted personnel, they must have some estimate of future vacancies by rating by month. To obtain such information, many sources are used, including the number of authorized petty officer advancements supplied by the advancement planner. A computer program based on ADSTAP System inputs is being developed to help in systematizing the interface between personnel planning and personnel control. This program, termed PROVAILS, is still in an experimental stage.

Using both PROJECT and SPAN output, as well as actual data generated by the Update System, PROVAILS computes a forecast of monthly on board strength by rating and pay grade. The program outputs a "straightline" listing of projected strength, a "best" estimate based on two alternative methods of forecasting, and an array of historical data. The various forecasts of on board strength by rating can be easily "tracked" through comparison with actual experience. PROVAILS computes this information for each rating and pay grade, for each month, and in the three forms discussed above, in some 41 seconds. The projective accuracy of this program is currently being assessed.

It is expected that PROVAILS will ultimately provide useful data for personnel planners to evaluate, by rating, the effect that their plans have on strength and, at the same time, provide distribution, assignment, and detailing managers with the input necessary to plan personnel movements more effectively.

Force Structure Prediction Program (TRANSITION)

Two of the most widely used techniques in forecasting are time series analysis (particularly exponential smoothing) and linear regression (or least squares methods). Both of these techniques are presently being investigated for potential application in predicting the length of service configuration of enlisted personnel--without reference to gains, losses, reenlistments, or advancements. This approach views the force structure matrix at each point in time as an element in a continuing time series. Hopefully, there is some characteristic in that time series that enables one to predict future force structures with some accuracy.

Rather than manipulating the raw data itself, this research is attempting to predict transition rates and then apply those rates to produce the actual forecast. A transition rate (R) is simply the difference between the population in $LOS_i(S)$, $Time_i(T)$, and LOS_{i+1}, $Time_{i+1}$ divided by the base population; i.e., $R_i = (S_iT_i - S_{i+1}T_{i+1})/S_iT_i$. Transition rates (sometimes called "survival rates") thus reflects the net decrease (or increase) in population from one year of service to the next over a period of time. It provides a method for determining the loss pattern over a career for a particular recruit class or "cohort," and a means of comparing such patterns to other cohorts.

At present, transition rates have been computed for each of 30 length of service intervals by quarter since 1957. As a result, there is a separate time series of transition rates for each given length of service interval (e.g., the transition from year 4 to year 5). With this data, research is proceeding to investigate different modes of exponential smoothing (such as single, double, and quadratic smoothing) separately and in combination, and test various methods of selecting the smoothing constant (e.g., best fit or adaptive). Because historical data is readily available, an error function employed as a criterion of forecasting accuracy will facilitate the evaluation of different techniques. A research memorandum will be prepared as soon as progress in this area permits.

Forecasting an Integrated Planning Data Base

One of the continuing concerns of ADSTAP development has been the integration of the personnel planning data base. The problem of establishing a common basis for developing personnel plans can be understood more easily in terms of the following example. Advancements are largely made to fill vacancies, and vacancies are computed by forecasting losses for each rating and pay grade. To determine recruit input it is necessary to predict total Navy losses. In planning A-school input quotas, future petty officer losses by rating must be estimated in order to know the quantity of trained input that will be required. To maintain on board strength within budgetary limits, the planner must predict the probable number of losses that will occur. Although all of the above cases involve forecasting losses, some require those forecasts by rating and some by total Navy, some by type of loss, and some by total net loss, some for six months in advance, and some for five years into the future.

Due to the specific forecasting requirements in each of these planning areas, various methods for projecting losses have evolved. It is not surprising, then, that the results are frequently inconsistent with one another. For instance, although the advancement planner must be able to predict vacancies by rating for at least six months ahead, the specific type of loss that generated that vacancy is of no concern. Similarly, while the strength planner is interested in projecting various types of losses because of their differential budgetary implications, the rating in which that loss occurred is of no consequence. Because of this, losses are forecasted by reference to Expiration of Active Obligated Service (EAOS) in some cases, by using average net attrition rates in other cases, and by projection of historical losses in still others.

To deal with this problem, the Projection Model was designed to produce a single, comprehensive forecast that would be equally useful for a large variety of planning functions. As a result, PROJECT generates forecasts at a degree of detail sufficient to serve enlisted personnel planning needs at both their finest and most comprehensive levels. The way in which this is accomplished can be understood best by a discussion of the various computer models and programs which constitute the third major component of the ADSTAP System.

PLANNING PROGRAMS AND MODELS

Specification of Planning Problems

Employing the Planning Data Base as a foundation, the Projection Model forecasts future states of the personnel system under the influence of a "policy set." The term "policy set" is nothing more than a group of personnel management objectives and/or the means of attaining those objectives. For instance, future personnel inventories can be projected given the following policy set: (a) petty officer requirements of 350,000; (b) a three month early release program; (c) total losses not to exceed 175,000; (d) minimum advancement opportunity equal to 5% of "green line" test passers; (e) recruit input of 85,000; and (f) a total Navy enlisted man-year average of 525,000 or less. The components of a policy set may consist of any variation of the above as well as a variety of other policies, plans or objectives.

Once the force structure has been projected--given a particular policy set--the real work of personnel planning commences. Deductively, the process of personnel planning can be specified as follows. A certain number of men, in various skills and at various pay grades, are needed each year in order to man the Navy's ships and their supporting shore establishment: these are the Navy's manpower requirements. In addition, certain numbers are needed <u>now</u> to assure sufficient personnel resources in the <u>future</u>. Given the Navy's needs, what can the Navy do about it? This breaks down into questions of how many? what kind? what skill level? what experience? when? at what price? and how? Such questions must be answered separately for some 100 occupational specialties in an operating environment characterized by changing requirements, unstable manpower budget, shortages of highly trained technical personnel and changes in the availablility of manpower resources.

Although the above considerations establish the setting for personnel planning, they do not focus on the actual substance of the function. By way of elaboration, the following list of questions is typical of the actual problems with which personnel planners must struggle.

How many recruits should be input this year and the next, and in what months should they be phased?

How many advancements or promotions should be made in order to meet requirements? In what ratings and pay grades?

What should training input be, in what schools, and when? What output can be expected, and when?

How can the cost of the force be reduced and requirements met? What are the trade-offs?

How many petty officers in each rating are feasible of attainment in terms of current and proposed policies?

How many careerists vice first termers in each rating are feasible in terms of current and proposed policies? What career ratio is desirable?

What should the length of service (LOS) requirements be for promotion in order to facilitate healthy promotion flow and still meet requirements? What effect do changes in LOS have on the force structure?

Is there an optimum average LOS for each pay grade and rating?

How should recruit input be allocated in terms of entry level requirements and future petty officer needs?

How many advancements should be authorized each month to reach a given man-year average?

What kind of force structure will x dollars buy?

What is a desirable level of promotion opportunity, or maximum acceptable stagnation, and how can that level be sustained?

What should the petty officer ratio be in each rating? How does it relate to the career ratio?

How can "sick" ratings or unstable inventories be identified in sufficient time to act? What can be done about it?

What constitutes a force structure that is "underaged?" "overaged?"

In reducing the cost of the force, what is the trade-off between dollars saved in retarded/reduced advancements and dollars expended due to increased longevity?

In the case of a drawdown, what should be the relationship between reduced recruit input, advancement stagnation, and early out programs? What are the advantages and disadvantages of each?

Of the total enlisted manpower budget, what should be the relative proportions devoted to pay and allowances? Permanent change of station travel? subsistence? others?

What is the "best" mix of recruit input, 2 x 6 input, early releases, and advancements to achieve a given force level? How should they be phased to achieve a given man-year average?

There are many more problems than those listed above, but the questions raised do suggest the "flavor" and range of personnel planning interests. To parallel the broad scope of personnel planning and policy development, a substantial number of computer programs and models have been designed under the ADSTAP aegis. In the following sections, each of these programs will be briefly described in terms of the specific problem or personnel planning function they address.

Strength Planning

Overview

One of the most critical subsystems of ADSTAP is the Strength Planning Model or SPAN. This computer program employs the predicted gains and losses produced by the Projection Model as input, and computes a series of strength plans under a wide range of alternative policy sets or options. SPAN is designed as the prime tool to be used by personnel planners in managing aggregate enlisted personnel resources. To understand the utility of SPAN it is first necessary to understand the structure and strategy of strength planning.

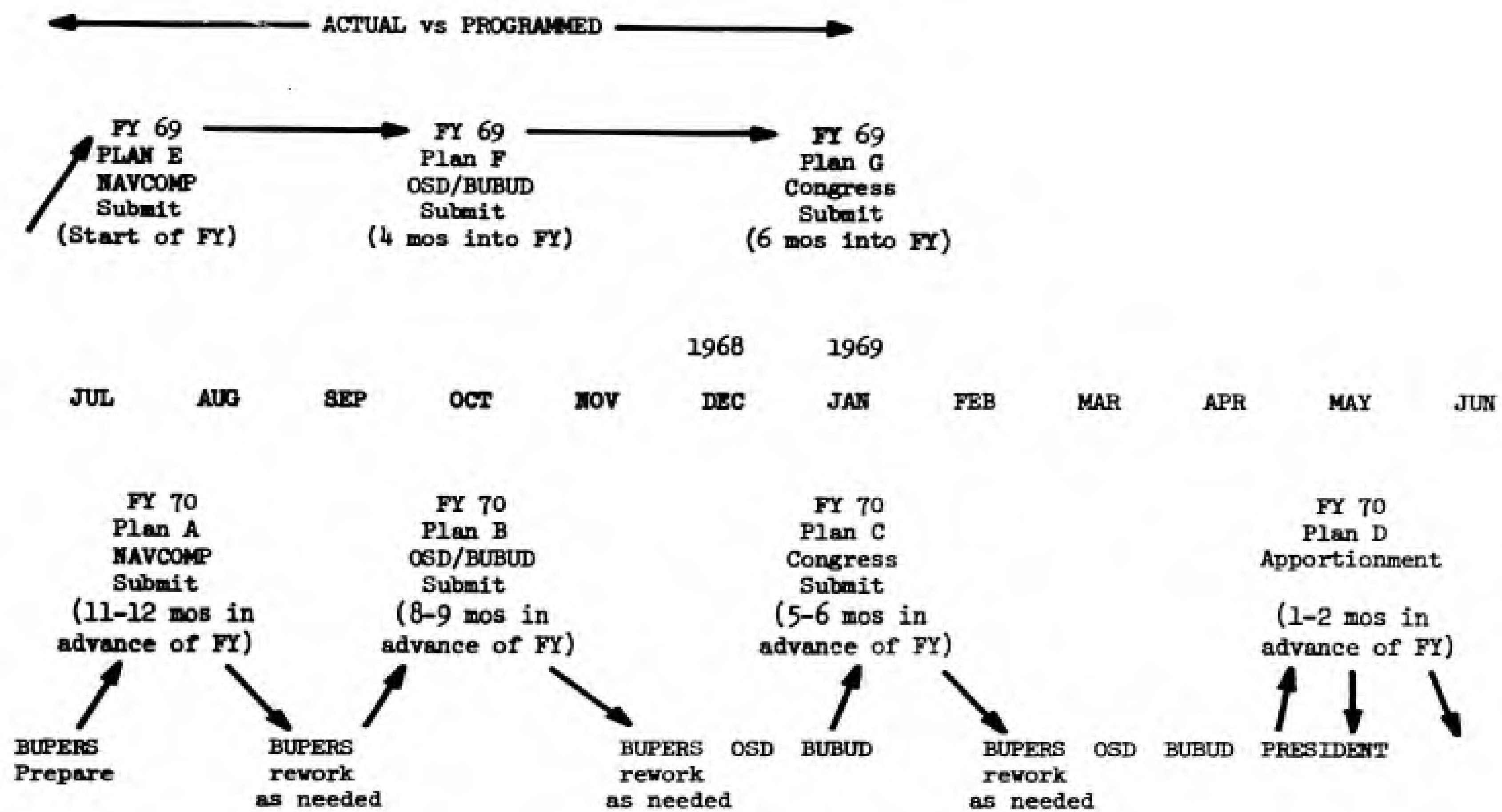
Strength planning is concerned with managing the force of enlisted personnel within budgetary constraints. Just as any other agency of the government, the Navy is given a fixed amount of money to spend on personnel. To ensure that changes to the personnel force over time do not create a structure that exceeds cost limitations in the current operating year or budget year, planning is necessary. Consequently, the composition of the enlisted force must be projected up to 24 months into the future in order to provide the strength planner with advance information necessary to make adjustments in planned recruitment, promotion, separations, and other policies which affect the size and shape of the force.

For any given fiscal year, there are a succession of Strength Plans, each one reflecting review by progressively higher authority based on shifting allocations within the total defense budget and limited fiscal resources. Figure 13 illustrates this cycle of strength planning.

The Strength Plan cycle is initiated by Plan A, which provides a projection of the following fiscal year about 12 months in advance. This enables the various offices to cost the force of personnel and thereby plan the Navy's manpower budget. In addition, it provides procurement specialists with the necessary lead time to contract for supplies. Generally, the first four Strength Plans are increasingly constrained reflections of Navy personnel management objectives and the means for achieving them. When strength planning moves into the current operating year, then the plans must be adjusted in reference to what actually occurs. At this point in the process, the planner "tracks" strength levels very closely to determine how much it deviates from planned strength--and adjusts accordingly.

Thus, in the initial part of the planning cycle the strength planner adjusts according to changes in policy, requirements, or other objectives; in the second stage, the planner adjusts in terms of actual events and the degree to which they deviate from the plan. In either case, succeeding plans incorporate those modifications necessary to account for changes since the last plan, and still achieve various manpower budgetary objectives.

FIGURE 13. STRENGTH PLAN PHASING (FY 69)



The basis on which the personnel force is budgeted is an annual average strength figure called Man Year Average or MYA. MYA is useful because it translates easily into budgetary terms by simply multiplying MYA by a unit cost or average cost per man year. Thus, if the average cost per year for personnel in pay grade E-7 is $10,000 and the projected average strength or MYA for E-7 is 15,000, then the cost for that pay grade during the subject year is about $150,000,000. The specification of MYA dictates the upper budgetary limitations for the top six pay grades as well as the total Navy. In strength planning, one of the major problems is to fulfill manpower requirements without exceeding MYA guidance from higher authority.

If, during the course of the current operating year, the number of enlisted personnel actually exceeds or falls short of Strength Plan projections, then the Navy will overexpend or underexpend its planned personnel budget. Such an instance is shown in Figure 14. If the strength planner determines that a projected overexpenditure is likely to occur, he has a number of alternatives. That is, he can adjust MYA by altering a variety of different personnel flows separately or in combination: planned recruit or reserve input can be rephased, enlisted advancements may be authorized in the later part of the segment in order to reduce MYA, or personnel may be separated before their normal expiration of service. However, these alternatives and many more are only viable to the extent that resources are available and that realistic constraints are observed. For instance, in reducing MYA for the bottom three pay grades, it is not feasible to introduce total annual recruit input in the last month of the fiscal year simply to diminish cost. As a result, in order to reduce the manpower budget for E-1 to E-3 personnel, recruits can be rephased by month only to the extent that the recruit training load throughout the year is relatively even. This, of course, is only one of the many constraints under which the strength planner must operate.

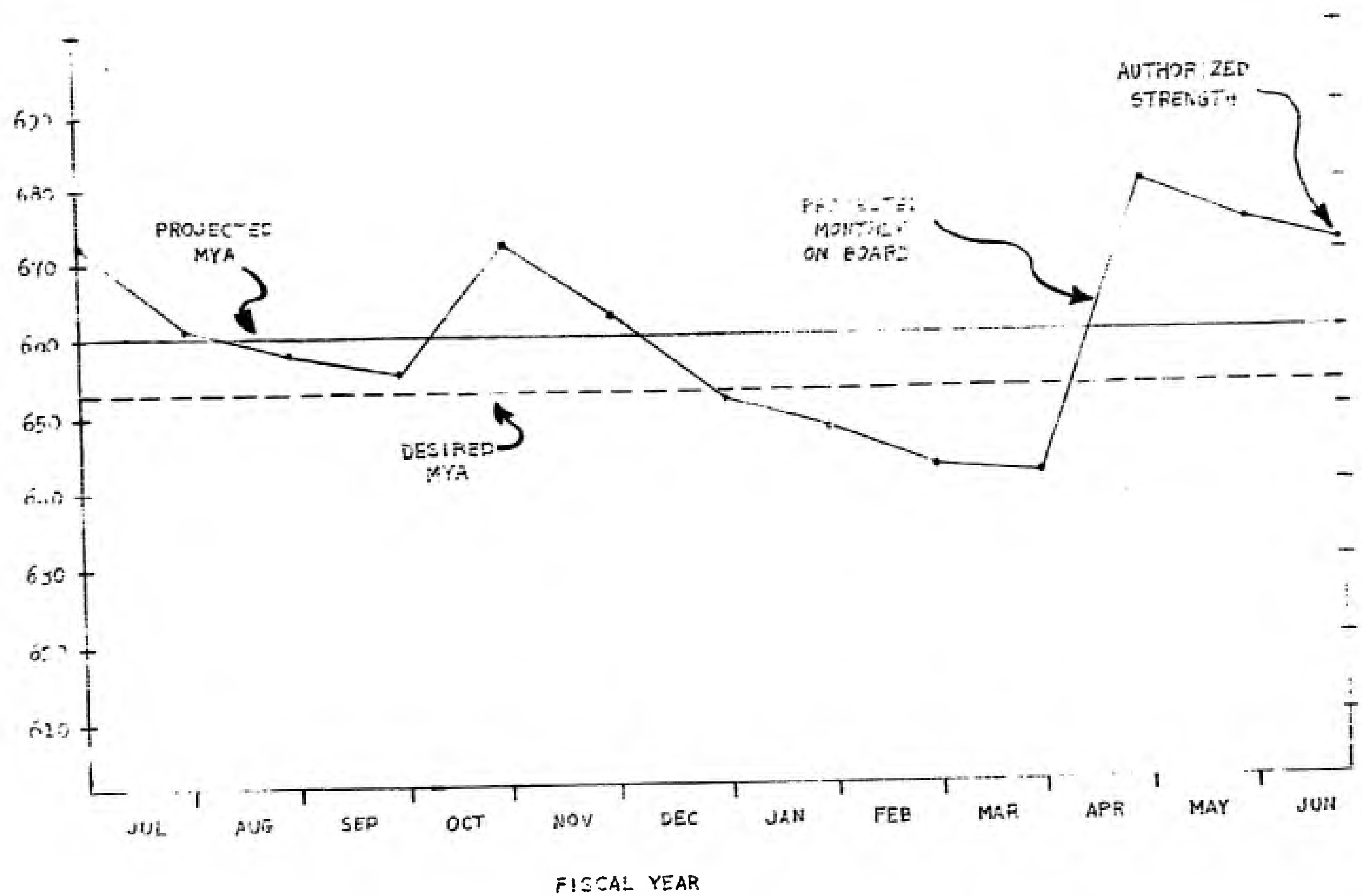
There are other considerations in strength planning besides those of budget. For instance, in order to plan for specified force levels the Navy must know how many advancements will be required and when they will be made, how many recruits will be necessary and when they should be trained, how many gains and losses are likely to occur and during what months. Because of the wide range of planning problems, the Strength Planning Model was designed to employ a highly flexible set of options.

Strength Planning Model (SPAN)

Whether operating to produce the Strength Plan document itself, or "driving" toward hypothetical end strengths, MYA, or cost levels, SPAN generates its output within a number of constraints that can be easily changed by the user. It should be noted that the number of alternative plans which might be produced by SPAN is a function of the combinatorial number of constraints and options.

Moreover, when the variety of options is combined with the range of data input possibilities, the number of alternative strength plans is for all practical purposes infinite.

FIGURE 14. RELATIONSHIP OF ON BOARD STRENGTH AND MAN YEAR AVERAGE



At the very least, a single run of SPAN can produce four plans--each one a successive revision of the preceding one to a greater or lesser degree. For instance, the first plan or base case is a direct reflection of a Projection Model run. Holding gains and losses constant, the second plan drives toward a hypothetical end strength by increasing or decreasing advancements and recruits. Operating in this way, an "end strength" run provides planners with information essential to establishing the feasibility of a given strength objective. Then, holding gains, losses, and advancements (and thus, end strength) constant, SPAN "drives" to a given man year average by rephasing advancements and recruits on a monthly basis. Last, SPAN produces a plan which achieves a given cost objective by modifying MYA. Figures 15 through 17 illustrate the structure and computational procedures employed in SPAN.

To recapitulate, the current prototype version of the Strength Planning Model (SPAN) embraces a number of capabilities. It can generate an Enlisted Personnel Strength Plan document with complete pay grade back up data for any current, budget, or other year and for any series. It provides a "rough-cut" costing by pay grade of any Strength Plan computed by the Model and, in addition, can generate a Strength Plan to meet a given "control dollar" for enlisted pay and allowances. If, because of certain policy constraints, SPAN cannot generate a Plan to equal the dollar objective, it will show exactly how close it came--again, by pay grade.

SPAN can produce a Plan consistent with that produced by the Projection Model, and then modify the number of advancements and recruits to meet a certain strength objective by pay grade. In "driving" toward a higher or lower end strength, the Model "straightlines" the monthly strength in the top six pay grades insofar as possible. If the Model cannot reach a given top six monthly end strength objective, it recycles to meet the yearly end strength--if it fails to reach the latter, the difference is carried down to bottom three pay grades. By evaluating the recruit/advancement numbers produced by such a plan, the feasibility of reaching various strength levels can be determined.

SPAN can also generate a Plan that is compatible with given Man Year Average (MYA) objectives. In this case, the Model runs "backward" by first computing a Plan and then shifting the month in which advancements or recruit input occur--while holding the number of advancements and recruits constant. There are well-defined constraints on these movements built into SPAN.

The Model treats advancements judiciously: (1) it maintains advancement segment boundaries E-4 to E-7, across which advancements may not shift unless overridden; (2) it operates with actual and projected advancements in combination and differentiates among non-rated, petty officer, and E-8/E-9 advancements--allowing different numbers of "actual" advancements for all three; and (3) it predicts E-2 and E-3 monthly advancements as a lagged function of previous E-1 and E-2 monthly gains (both the prediction and lag period are subject to user control).

In dealing with actual data, the Model is capable of modifying projected data while allowing past months of actual data to remain undisturbed. As a result, already authorized advancements--even those for an entire year, such

FIGURE 15. STRUCTURE OF THE ENLISTED STRENGTH PLANNING MODEL (SPAN)

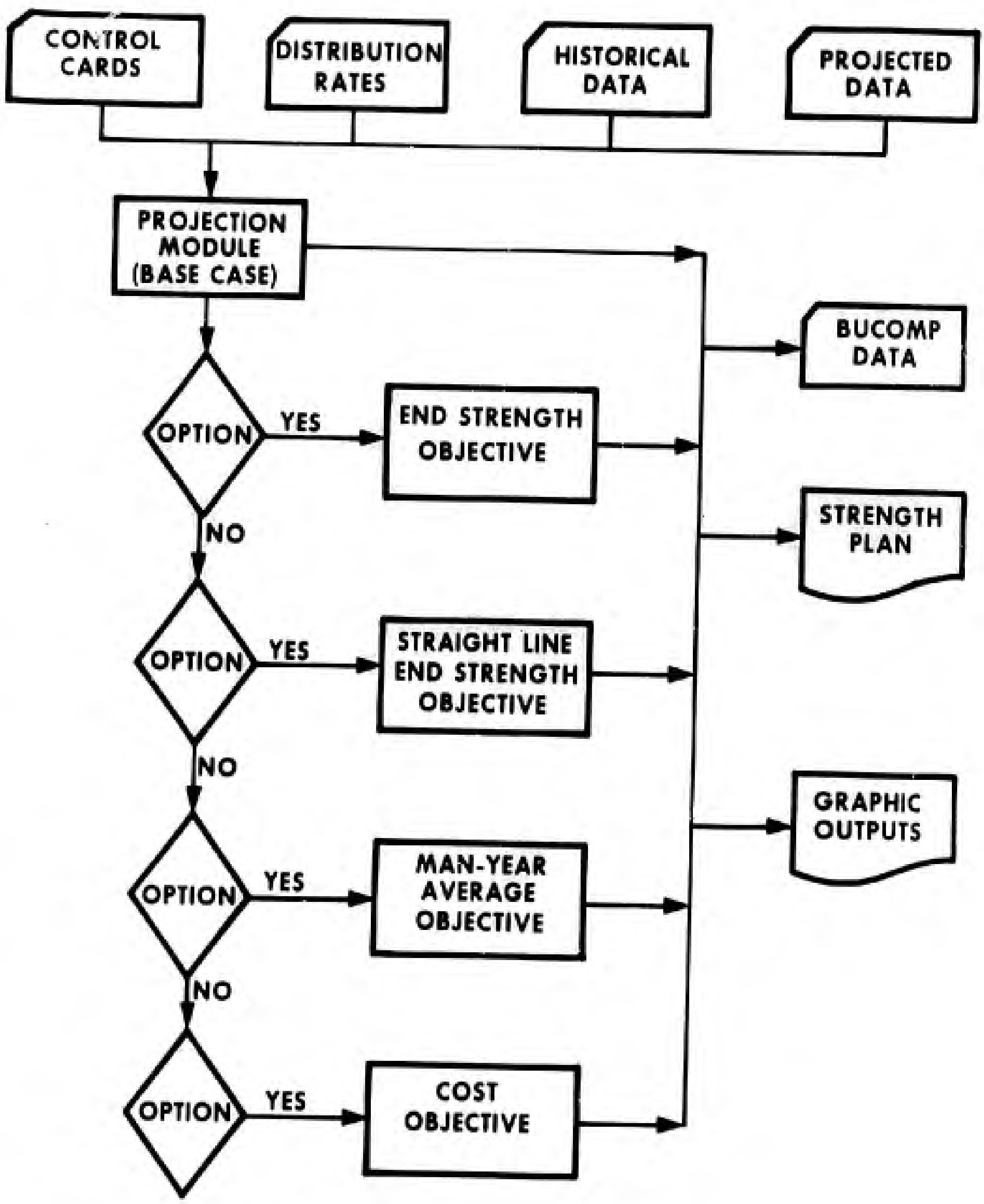


FIGURE 16. STRENGTH PLANNING MODEL - COMPUTATIONAL PROCEDURE I

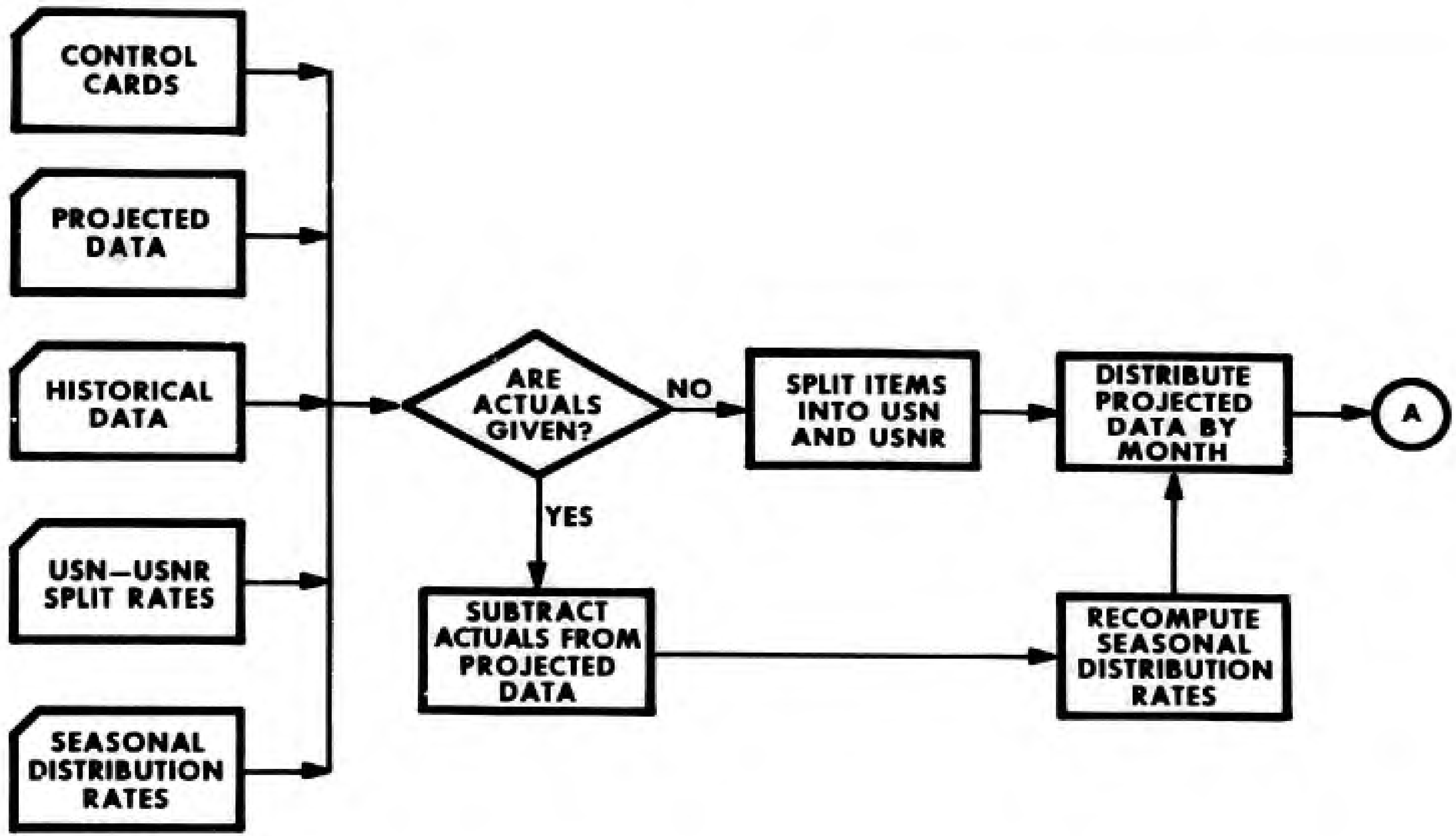
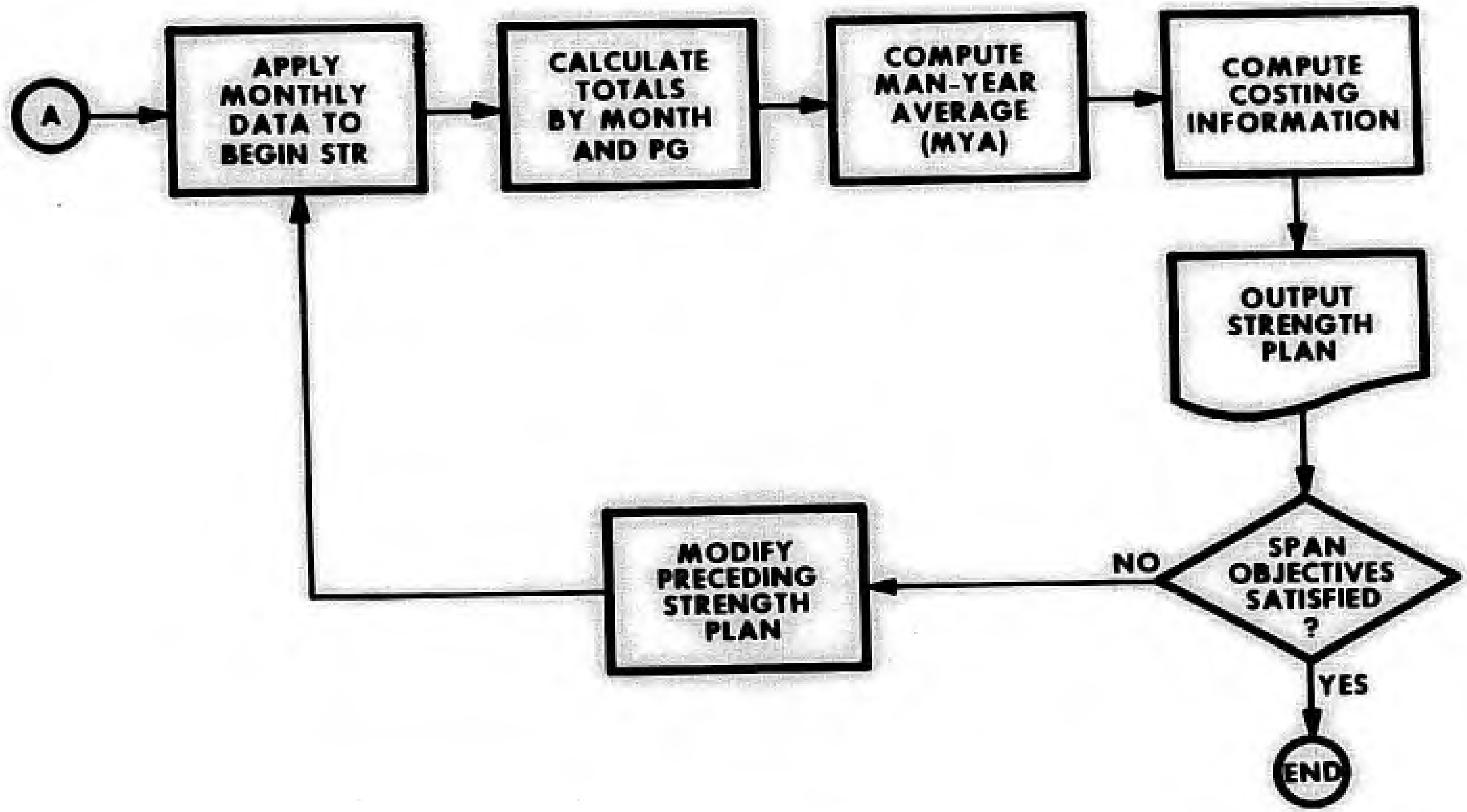


FIGURE 17. STRENGTH PLANNING MODEL - COMPUTATIONAL PROCEDURE II



as E-8 and E-9--may be "frozen" even while other variables yet uncommitted may be modified. In addition, SPAN recognizes the built-in reporting lag by introducing a modification lag period three months beyond the number of months of actual data. For example, although there may be three months of actual data, the planner cannot really alter any variable for six months because the second three month period is generally beyond control as far as system response is concerned. It is possible under certain circumstances to reduce that lag period and that is why a "management override" has been provided for this feature of the Model.

When "driving" toward end strength or MYA objectives, SPAN operates within constraints established by the user which reflect current or proposed policy. For example, there is a minimum and maximum limit for each month's recruit input which can be established in order to "level-load" input to the Navy. There are many other features of SPAN which constitute major improvements over earlier versions: e.g., 2 x 6 input can be treated as a controlled variable or be fixed; USN and USNR populations are computed separately; new control cards have been designed; optional card output has been programmed in order to interface with GRAMP, BUCOMP, and ADIN; and an option has been introduced to allow straight-lining of "bottom three" end strength--among others.

SPAN has achieved a good deal of flexibility and power in its current prototype in that (a) it can produce plans in terms of the Projection Model generated "base case," (b) it can "drive" to end strength objectives, (c) it can "drive" to MYA objectives, or (d) it can "drive" to cost objectives. Moreover, SPAN performs these four operations in any combination. Yet, even with all of the capabilities described above, there is still room for improvement. As a result, a number of future developments in the area of strength planning have been anticipated and the research initiated to accomplish these objectives. In this regard, one development in particular is worthy of mention--the Early Release Methodology. Because of the technical detail and jargon involved in describing early release strategies, and their relationship to strength planning and the operation of SPAN, this discussion has been restricted to Appendix A: Loss Management and Early Release Strategies.

Even without a built-in early release feature, however, the Strength Planning Model not only speeds up the work performed by the planner--in the case of computing a complete Strength Plan with pay grade backup, it is about 10,000 times faster than manual methods--but more important, it provides the planner with a capability that is simply non-existent at present. This is the capability to produce a large number of alternative plans in rapid succession and select the one which in the judgment of responsible authority best meets the objectives of the Navy within various constraints. As noted previously, one of the more important constraints in strength planning is that of cost. The next section describes the element of the ADSTAP System which deals most directly with the enlisted manpower budget.

Manpower Budget Planning

Relationship Between Personnel and Financial Management

Preliminary to any description of computer programs designed to assist in planning the enlisted manpower budget, it would be useful to provide some background on financial management and the military personnel budget. The achievement of personnel management objectives is frequently circumscribed by limited fiscal resources and, indeed, by the appropriation process itself. To understand the interaction between fiscal management and personnel management, the following discussion has been provided.[7]

The appropriation for "Military Personnel, Navy" (MPN) accounts for roughly one quarter of the Navy's total appropriations. It provides for pay, allowances, subsistence, clothing, permanent change of station travel (including transportation of dependents, household goods, and privately owned automobiles), and other costs such as death gratuities, interest on deposits, mortgage insurance premiums, and employer's contribution to Social Security. Determination of the dollars required is generally dependent on the strength, composition, deployment, and turnover of forces.

Although the MPN appropriation is authorized by Congress as a total figure, it is justified under a number of basic budget "activities". A brief description of the major items included under each of these budget activities is listed below:

1. Pay and Allowances

This activity covers officer and enlisted naval personnel on active duty, including midshipmen at the Naval Academy, aviation cadets, officer candidates, and aviation officer candidates. It includes basic pay, quarters and subsistence allowances, sea and foreign duty pay, special pay for physicians and dentists, lump sum leave payments, reenlistment bonuses, overseas station allowances, the Government's contribution to the Federal Old-age and Survivors' Insurance Trust Fund, purchase of individual clothing for initial issue to enlisted personnel, and payment of clothing maintenance allowances. This activity uses about 80 to 90 percent of the funds appropriated for "Military Personnel, Navy."

2. Subsistence-in-Kind

This activity provides rations for eligible naval personnel who are not receiving a cash allowance for subsistence, rations for inactive retired and Fleet Reserve enlisted personnel who are under treatment at a naval hospital, funds for the replacement of emergency rations and the rotation of operational rations., etc. Approximately 5 to 10 percent of the appropriation is in this activity.

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[7]The initial part of this section has been adapted from Committee on Defense Participation in the Joint Accounting Improvement Program, Management of the Military Personnel, Navy Appropriation (A Study Made by Representatives of Bureau of the Budget, General Accounting Office, Department of the Navy, Office of the Assistant Secretary of Defense (Comptroller)), May 1962, pp I-1 to VIII-2.

3. Movements, Permanent Change of Station

This activity covers the expenses associated with travel for individuals and groups of naval personnel and their dependents involved in a permanent change of station (PCS). This includes dislocation and separation travel allowances, storage of household goods, and transportation of personal property. Also included are travel expenses for members and dependents when being assigned to or separated from the Navy. This activity represents another 5 to 10 percent of the appropriation.

4. Other Costs

This activity includes the payment of interest on money deposited by enlisted personnel, payment of premiums on servicemen's mortgage insurance, and death gratuities. Less than one half of one percent of the appropriation is represented by this activity.

The amount of money required for MPN in any given year is partly a function of the size and configuration of the required naval manpower force and partly a result of its prospective operational deployment. This appropriation is administered under open allotment techniques, whereby the appropriation can be charged on a world-wide basis without limitation as to amounts. Broad authority is given to disbursing officers of the Navy to make payments for those purposes prescribed under the heading of "Military Personnel, Navy," but the management and control of funds is the responsibility of the Chief of Naval Personnel. Because of this, fund requirements must be estimated with a high degree of accuracy and such estimates require considerable justification.

Although the Navy has been fortunate in avoiding over-expenditure of the MPN appropriation, the possibility remains a constant threat. The desire to get the most Navy possible within the appropriation, together with rising PCS and dependency costs, tend to make management deficit-conscious at all times. Such sensitivity is warranted because even the slightest breach of the appropriated amount attracts as much criticism as a large departure.

These circumstances have been the subject of growing concern and expanded effort in the areas of both financial management and personnel management. Increasing scrutiny given to requests for personnel funds is reflected in the desire of all levels of review to restrict the appropriation to minimum possible levels.

At the same time, the Navy is understandably determined to make the fullest possible use of the appropriation. In short, a situation characterized by decreased funds and increased needs places a tremendous burden on those charged with the responsibility of force management.

Although all services have similar problems in developing and controlling their respective manpower budgets, the management of the Navy's military personnel appropriation occurs under many circumstances which are peculiar to naval service. Basically, most Navy operations are concerned with the ocean. In fact, almost 60% of the total Navy population is assigned to an afloat craft of some kind. While these vessels have varying degrees of self-sufficiency they require a certain amount of shore support, a substantial part of which is based overseas.

Each ship has a home port, with the largest share based in the continental United States and the remainder overseas. Each ship departs from its home port and engages on it mission but, sooner or later, the ship must return to its home port for servicing. When an enlisted man is assigned to a ship, his family may move to the ship's home port: this move is part of the change-of-station travel bill for the Navy. Some families do not elect to live at the home port during the sailor's tour afloat. In such cases the family may be transferred to the permanent home of the family and this too is financed by the Navy.

The high degree of mobility of the Navy makes it apparent that the assignment of a ship to a home port is not a permanent assignment. Not only do strategic and tactical determinations influence the assignment but physical and mechanical factors involved in the maintenance of the ship also require consideration. Together they create circumstances in which moves of vessels from one home port to another are not infrequent. The financial problem is introduced when it is recognized that when the ship moves the family is also entitled to move.

Space limitations aboard most vessels increase the training requirement. In addition to the great need to learn to cope with the increasingly complicated weapons systems, it becomes necessary for naval personnel to double up in their skills. Some enlisted personnel, especially those in electronic and nuclear activities, are trained for as much as three years before their efforts are applied in a productive capacity. As a result, the growing investment in personnel inevitably places greater emphasis on the quality of personnel recruited as well as their retention.

Another area of particular concern to the Navy is that of geographic dispersion and mobility. The major difficulty encountered here is the reporting problem as complicated by distances, by afloat circumstances, and by constant movement. One aspect of dispersion, other than the mechanical difficulty presented in achieving prompt and accurate reporting, is the difficulty of communicating instructions to personnel when they are scattered completely around the globe. Changes in methods and procedures are not achieved overnight and necessarily involve some period of adjustment. Dispersion and the long periods away from home also require an extensive system of family allotments. The earning of a man's pay in one location and its payment by another agency at a different location halfway around the world creates a complex data collection problem.

Given the naval environment and the structure of the MPN appropriation, there are many problems in estimating fund requirements. First of all, practically all budget computations must be developed in considerable detail since there is a wide spread in the rates which are authorized within nearly all pay and allowance items. For example, in preparing the estimate for basic pay, it is necessary to predict the monthly phasing and pay bracket or longevity distribution of the personnel expected to be recruited, separated, retired, reenlisted and promoted within each military pay grade.

The number of reenlistments is also difficult to predict and has a far-reaching effect upon actual fund requirements. In each fiscal year large numbers of personnel complete their enlistment contract or active duty obligation and become eligible for release. Of this group, a varying percentage will immediately reenlist. An accurate forecast of this number of reenlistments is very important because of its significant impact on fund requirements. For example, if the forecasted number is understated, not only will the estimated fund requirement be inadequate for reenlistment bonus but also for many other pay and allowance items and permanent change of station (PCS) travel costs. Because reenlistees have completed a number of years of service and have a higher number of dependents than new enlistees, considerably higher rates will be required in estimating costs for basic pay, basic allowance for quarters, basic allowance for subsistence, cash clothing maintenance allowances, proficiency pay, overseas station allowances, and transportation of dependents and household effects.

Another problem area is the number of personnel with dependents who must be housed or paid cash basic allowance for quarters and transported by funds from this appropriation. Both the number of personnel with dependents as well as the sheer number of dependents is not only beyond military control but is difficult to predict accurately. Underestimation of the number of personnel with dependents has the effect of not providing an adequate budget for basic allowance for quarters, station allowances - overseas, and associated permanent change of station expenses for transportation of dependents and shipment and storage of household goods. Underestimation of family size results in even further fund shortages because the average rates are too low for the number which were included in the budget.

Yet another factor that makes it difficult to forecast the required manpower budget relates to the procedures and responsibility for ordering movements of personnel, transfers of ships among home ports and home yards, and transfers of aircraft squadrons from one station or ship to another. Naturally enough, movements of naval personnel and units are not specifically established from the standpoint of financial management, but are generated by operational commitments. As a result, it is especially difficult to accurately predict future PCS costs and budget accordingly.

Unlike other appropriations, an exceptionally large part of the total military personnel appropriation must be considered as a fixed cost for personnel in service. Once on board, military personnel must be paid at statutory rates and increases resulting from length of service must be honored. Enlisted men subsisted in messes must be furnished prescribed rations regardless of the current price level of food. When not furnished public quarters, appropriate allowances must be paid for quarters in amounts which vary by pay grade and number of dependents. Costs for transportation of dependents and household effects may be incurred whenever eligible military personnel are transferred. Thus, most costs borne by the military personnel appropriation cannot be avoided or deferred while the member continues in service. A similar situation exists when attempting to save funds through reductions in force, because of the mandatory nature of the various entitlements paid at the time of separation or release from active duty.

There are severe limitations on management flexibility and latitude in affecting the cost of the force. Almost invariably each action taken is characterized by a long lead time before it affects available funds. After all, the planning and preparation and system response necessary to put revised recruitment, training, reassignment, and movement schedules into effect for a force of 600,000 personnel is no small matter. In any case, tangible savings are not realized for some time after an action takes place.

Recognizing this lead time requirement, there are several courses of action which could be taken when a service is forced to reduce the amount being spent. The first and most obvious way of reducing the cost of the force is to reduce its size. This can be done by decreasing input, discouraging reenlistment, or releasing personnel before their normal date of separation. Reducing input has the unfortunate effect of tending to dry up the source of desirable personnel. In addition, it creates humps and valleys in the procurement or input pattern which introduces difficulty in later years. Further, the pay of new enlistees is the lowest of all personnel and therefore many men will have to be turned away before much money is saved.

The discouragement of retention without careful quality controls generally wastes talent and investment in training. In addition, for many people it creates an unfortunate morale situation. This would be particularly true of those who came to the Navy with careers firmly in mind.

The early release of personnel will reduce costs, but even this technique becomes uneconomical to use if the action is taken too close to the end of the fiscal year. At a certain point the payment of separation benefits is such as to exceed the basic pay that the individual would have drawn for the remainder of the year. The additional separation costs for unprogrammed early releases lessens the savings in current year funds since three to four month's active duty pay and allowances must be saved for each enlisted man (and even longer for officers) just to break even. Only longer periods produce some net savings. Also, there is some question as to the tradeoff between savings in pay and allowances due to early release and the costs attributed to lost productivity from experienced, trained personnel.

In addition to the above, consideration may be given to changing the longevity composition of the Navy as one way to save money on military personnel. This is even more difficult than size reduction because it is impossible to stop the increase in length of service which is accruing to each man in the Navy--although the longevity configuration of the force may be affected over a longer time frame.

Another method of cost reduction is by delaying promotions. However, because the differential is the sum of the potential pay raises, it is obvious that the savings are relatively small. Moreover, the effect of "retarded" advancements on morale is easily predictable. Other administrative actions which may be taken to save funds involve the deferment of permanent change of station movements and other travel. Of course, for married men afloat, this too could create a serious morale problem. It is clear that, for this and other methods, unless action is taken early in the fiscal year it is extremely difficult to realize immediate MPN savings. It is more likely that any significant savings resulting from such actions will accrue to subsequent fiscal years rather than the current operating year.

In summary then, the reduction of costs is primarily dependent upon control over the number of personnel for whom costs are incurred. This control during the operating year is based on the ability to schedule or reschedule losses and gains. In addition, the release of personnel prior to their normal date of separation, the discouragement of reenlistment, and the reduction in the procurement of new personnel all provide ways of saving current year funds although these methods have certain drawbacks.

The foregoing discussion was designed to provide an understanding of (1) the structure of the Navy military personnel appropriations, (2) some aspects of personnel budget development and forecasting, (3) problems involved in budgetary cost control, and (4) the interface between enlisted personnel management and financial management. With this framework in mind, it should be noted that the relationship between the ADSTAP System and the budget formulation process was a predictable evolution of development effort on the Strength Planning Subsystem and the Projection Model.

ADSTAP and Manpower Budget Planning

One of the particular advantages of the ADSTAP System is its capability of forecasting future force structures within a given policy set. As a result, decision makers can determine a set of personnel management objectives and project the effect of that set on the future longevity configuration of the force. The use of such a capability in estimating enlisted pay was immediately obvious since, according to statute, pay is determined by grade and longevity. It is an easy step from projection of the personnel force structure to projection of estimated pay based on that structure.

In addition to the above, ADSTAP has an obvious role in budget planning through the Strength Planning Subsystem. As noted in the previous section, strength planning is concerned with the management of the active duty force structure within constraints of grade management policy and budgetary cost. Because of the need to cost each Strength Plan to determine its fiscal feasibility, the requirement for an "enlisted budget cost subsystem" as an extension of the ADSTAP System became readily apparent. Enlisted Strength Plans contain the essential elements necessary to derive a statement of fund requirements. With the capability of rapidly producing a great number of alternative strength planning strategies through use of SPAN, it was necessary to develop an equally rapid method of "costing" those strategies.

Budget Cost Management Program (BUCOMP) and Budget Cost Data Bank (BUDAB)

As a first tentative step in the direction of a "Budget Cost Subsystem," research was initiated to close the gap between a computerized personnel planning system and a hand-calculated budget planning system. This first effort was restricted to enlisted pay and allowances simply because it capitalized on various features of the ADSTAP System. As noted previously, an important feature of the ADSTAP System is its capability of projecting gains, losses, and on board strength by pay grade and longevity. Taking advantage of this capability, the first version of a computer routine termed Budget Cost Management program (BUCOMP) was designed to compute MPN Activity II budget costs--namely, Enlisted Pay and Allowances. BUCOMP employs input from (a) the Strength Planning Subsystem, in the form of predicted gains, losses, and reenlistments, and from (b) the Projection Model, in the form of enlisted force structures. Such input, together with unit costing factors and other data supplied by budget planners, is used to calculate the estimated budget costs attributed to a given Enlisted Strength Plan. The structure of this program as presently constituted is shown in Figure 18.

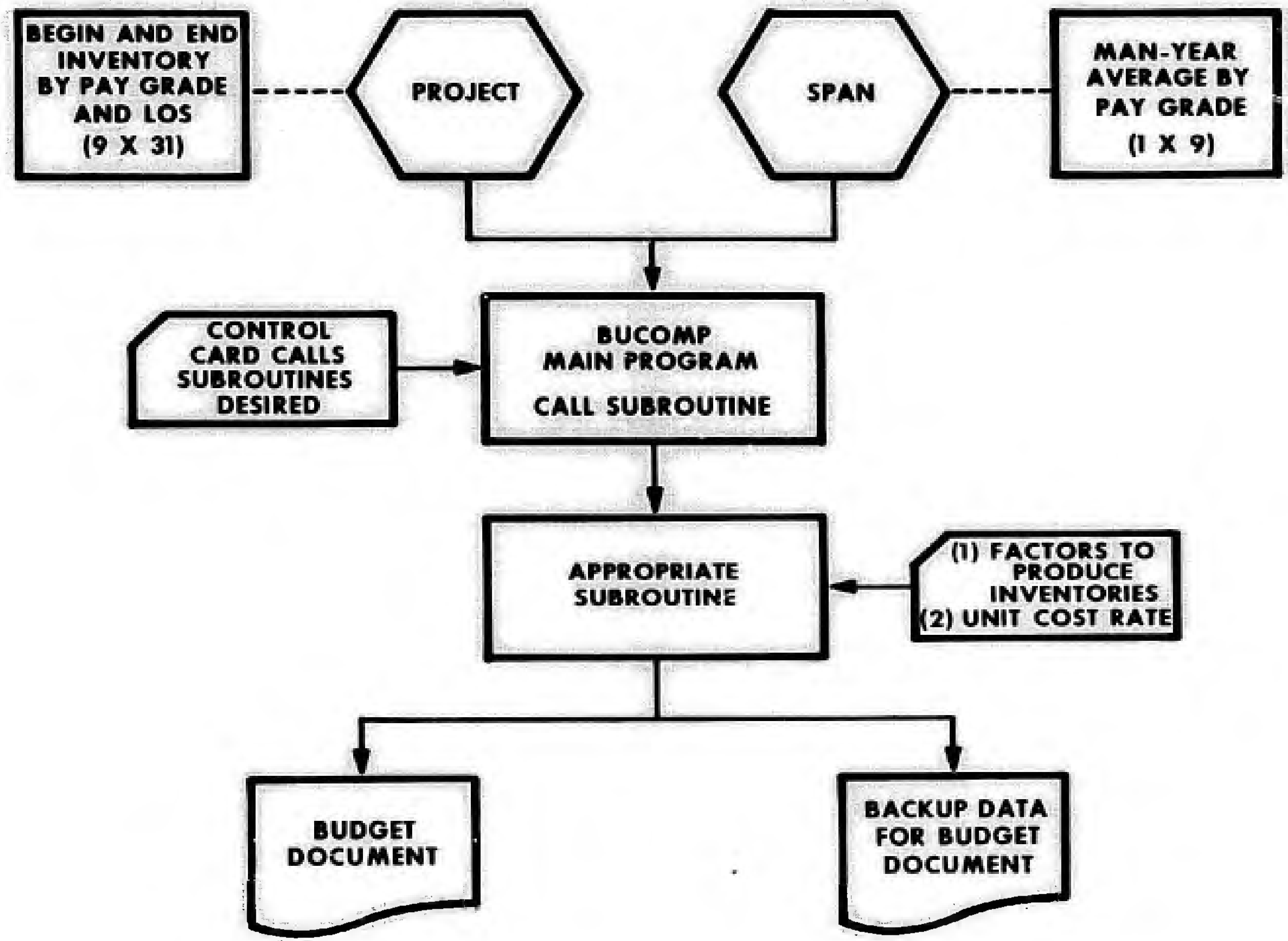
Although BUCOMP is a relatively simple and straightforward computer programming application, it has already proved its value. First, it provides budget planners in the Active Plans Costing Branch (Pers-A13) with a rapid and convenient computerized method for estimating the enlisted pay and allowance costs involved in alternative Strength Plans while they are still in the developmental stages. This, of course, makes it possible to evaluate the financial trade-offs involved in different planning options. Second, the current capabilities of BUCOMP are considerable and important in that enlisted pay and allowances represent a large share of the MPN budget. BUCOMP computes these Activity II budget costs about 150 times faster than hand calculation methods, which provides planners with time for analysis as opposed to the generation of single or restrictive budget strategies. Third, the program can compute the effect of pay raises and changes in entitlement, and because of its input flexibility, it has other capabilities not originally anticipated in costing enlisted personnel Strength Plans. For instance, the user (Pers-A13) has employed BUCOMP for "tracking" obligations as well as budget planning.

While the current version of BUCOMP only represents an initial "rough-cut" of the costing subsystem, it has already seen frequent operational use under a variety of conditions. Nevertheless, even in the case of enlisted personnel, budget costs in the areas of subsistence and PCS movements are currently beyond the scope of the computer program. In terms of a comprehensive personnel budget costing sytem, it is clear that other budget activities must be encompassed within the framework of BUCOMP; and to achieve this, a sizeable effort in research, systems analysis, and computer programming must still be initiated.

In any event, in the course of this research it soon became apparent that pay and allowances of the enlisted force could not be costed in isolation of the remaining MPN budget activities. As a result, it was necessary to enlarge the scope of the research to include costs attributed to subsistence of enlisted personnel, permanent change of station, travel, and other military personnel costs comprising the MPN budget. Fundamentally, the purpose of budget costing research is to develop a total, integrated military personnel budget cost model that can be used to produce planning information and test alternative personnel budget costing strategies. As an inherent part of this research, and a necessary precondition to much of the required analysis, it is necessary to develop an historical personnel budget cost data base beginning with a thorough investigation of potential data sources.

The research approach anticipates the following tasks: (1) refinements to the currently operational version of BUCOMP, which encompasses pay and allowances of enlisted personnel; (2) analysis and programming of subroutines to produce budget information for Activity I (officer pay and allowances) and Activity III (midshipmen); (3) analysis and programming of a subroutine to produce Activity VI budget data (other personnel costs); (4) analysis of the PCS system and the subsistence costing system, and subsequent programming of Activities IV and V; (5) integration of subroutines, and test and evaluation of the total MPN budget cost model; and (6) comprehensive investigation of data sources and development of a computerized historical personnel budget cost data base.

FIGURE 18. STRUCTURE OF THE BUCOMP PROGRAM



The first step in the above process has been largely completed, although there may be future modifications in management-oriented program controls. The operational version of the Budget Cost Management Program (BUCOMP I) calculates naval enlisted personnel pay and allowance costs based on various inputs provided by personnel and budget planners in the Bureau of Naval Personnel.

It is intended that future BUCOMP research will encompass the following: (1) an obligation and budget planning system to determine, (a) current budget status vice actual performance and (b) personnel planning changes required to meet authorized dollar constraints; (2) historical analyses of the relationship between reductions or increases in the force and particular items of pay; (3) analysis of relationships between strength configurations and operational/rotational PCS movements; (4) analysis of relationships between subsistence on board loading to strength reduction or increases; (5) projection and analysis of relationships of time in grade, rate, age, and advancement opportunity to dependency status; (6) methods for projecting training travel costs based on school input and training plans; and (7) analysis of historical data to determine budget requirements for items of pay related to billets.

This involves a considerable effort not only in system design and programming, but also a massive research task in locating, analyzing, and otherwise developing a personnel budget costing data base. With extraction and data analysis programs, in addition to computerized storage and retrieval, this data base becomes the Personnel Budget Cost Data Bank (BUDAB). The form of BUDAB has not yet been designed but the need is critical. At present, there is no reliable, comprehensive, accurate, and timely source of information concerning the historical interrelationships of the many variables affecting expenditures. Data currently available are in many forms (from documents to magnetic tape), in many dispersed geographical locations, and as yet unevaluated for research and systems utilization. In tandem with BUCOMP research, significant resources will be devoted to the development of BUDAB. Not only does the efficacy of any BUCOMP program depend on this data base for both development and operational use, but such information is essential for further development of the ADSTAP System as well as managerial use in budgetary decision making.

Personnel Costs, Budget Costs, and ADSTAP

The focus of the preceding discussion was on the MPN appropriation and personnel budget costs, as distinct from other kinds of costing criteria. It should be noted that budgetary considerations are an important factor in making personnel management decisions--but it is not, by any means, the only factor, nor is it the only costing factor. In choosing among alternative personnel planning strategies, the short-term budgetary implications may represent only a small part of the total cost. For instance, in analyzing the cost of a given billet one can obtain a good approximation of that cost by determining the pay grade and average time in service for incumbents in that billet, and then applying the appropriate statutory rates to yield an estimate of likely pay and allowances. To increase the accuracy of the estimate, one can "crank" in PCS, subsistence, dependency, and other cost factors in order to come up with a fairly good approximation of what that billet may cost the Navy in terms of the current or planned MPN budget.

However, these costs represent only the surface portion of the proverbial iceberg. Also attached to each billet are recruiting costs, a variety of training costs, and even retirement costs which occur after an individual completes a career of active duty.

Thus, with the necessary data and techniques, it is possible to compute the "costs of manning the authorized billets with people having requisite skills, in terms of the investment and operation cost to the U.S. Government, for each year of the established life-cycle of a given rating."[8] Such a "life-cycle" approach to manpower costing has been employed in a contractor effort to develop a Billet Cost Model (BCM). In order to tie this capability to the ADSTAP System, another program was designed by the same contractor. This latter program, called Interim Per Capitia Cost Model (INPER), employs ADSTAP Projection Model output in the form of force structure matrices and BCM-generated cost data, and computes a pay grade by length of service matrix for each rating containing per capita unit costs that have been "annualized."[9] These per capita cost matrices are then input to the Policy Planning Program (POLIP) of the ADSTAP System, where they are multiplied against projected population matrices to obtain an estimate of "life-cycle" costs. Awaiting future research and analysis is the comparison of budget and life-cycle (or "real") costs. Only then will the Navy have a complete set of tools for systematic and comprehensive decision making in the area of personnel management and a more thorough understanding of the cost trade-offs involved in selecting among a set of alternative strategies.

By way of introducing the next ADSTAP subsystem, it will be recalled that one of the methods of cost reduction lies in the Navy's Enlisted Advancement System, particularly the ability t ontrol the scheduling of authorized promotions or advancements. The next section considers this, and many other advancement planning problems.

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[8]B-K Dynamics, Inc., Billet Cost Model: Users Manual, Rockville, Md.: B-K Dynamics, Sept. 1970 (TR-3-159).

[9]B-K Dynamics, Inc., INPER: Interim Per Capita Cost-Computation Methods and Operational Controls, Rockville, Md.: B-K Dynamics, Jan. 1971 (TR-3160).

Enlisted Advancement Planning

Overview

The most critical and responsive method of assuring sufficient petty officers in the Navy's various pay grades and ratings lies in the Enlisted Advancement System. As a result, the kind of techniques available to manage enlisted advancements (or synonymously, promotions) becomes extremely important. Enlisted advancements serve a three fold managerial function, aside from their obvious purpose in providing adequate promotion opportunity and their impact on the morale of enlisted personnel.

First of all, in the absence of some system for planning enlisted advancements it would be impossible to achieve grade management objectives as represented by authorized petty officer strength levels. By carefully planning promotions in each pay grade the Navy is able to meet, but not exceed, petty officer levels established by higher authority. This is particularly important in reaching specific end year objectives. A second function of advancement planning involves the scheduling of monthly promotions in such a way as to attain a particular level of strength, on the average, during the course of a fiscal year. The cost of the enlisted force can be expressed in terms of a "man year average" by pay grade, and the advancement system is the most effective medium for achieving monthly strength objectives which do not exceed the petty officer man year average. A third consideration in advancement planning involves the demands placed on the system by the need for fleet readiness. To meet the fleet's personnel requirements, adequate numbers of personnel in each rate must be available throughout the year for distribution, assignment, and detailing to the various fleet billets. Because the advancement system is the major contributor to the petty officer force, advancement planning to meet fleet needs is at least as important as staying within budgetary guidelines and petty officer strength authorizations.

Enlisted advancements are generated by a "mixed merit" system, in which centrally administered and scored examinations constitute a significant part of the "merit" (as well as awards, performance ratings, etc.), and both time in service and time in grade constitute the Navy's minimal requirements for experience. For petty officers at pay grades E-4 through E-7 such examinations yield a reservoir of advancement "eligibles" twice a year (for E-8 and E-9, once a year). The advancement planning cycle is phased around these examinations, as shown in Figure 19.

Since each advancement segment is six months in length, the planner must predict vacancies at least eight months in advance to provide adequate lead time for planning and authorization of advancements. The method employed to calculate the number of advancements required for a segment is called "carrydown." An example of this method is shown in Figure 20 for a hypothetical rating. Although the method is simple, the task of predicting vacancies and making calculations for every petty officer pay grade of every rating creates a considerable burden. This is complicated by the fact that many rating structures split into two or more specialties as one proceeds down the pay grade ladder, and even one structure is split on the way up, as illustrated in Figure 21.

FIGURE 19. MONTHS COVERED BY THE PLANNING PERIODS AND ADVANCEMENT SEGMENTS ASSOCIATED WITH THE AUGUST AND FEBRUARY ADVANCEMENT EXAMINATIONS

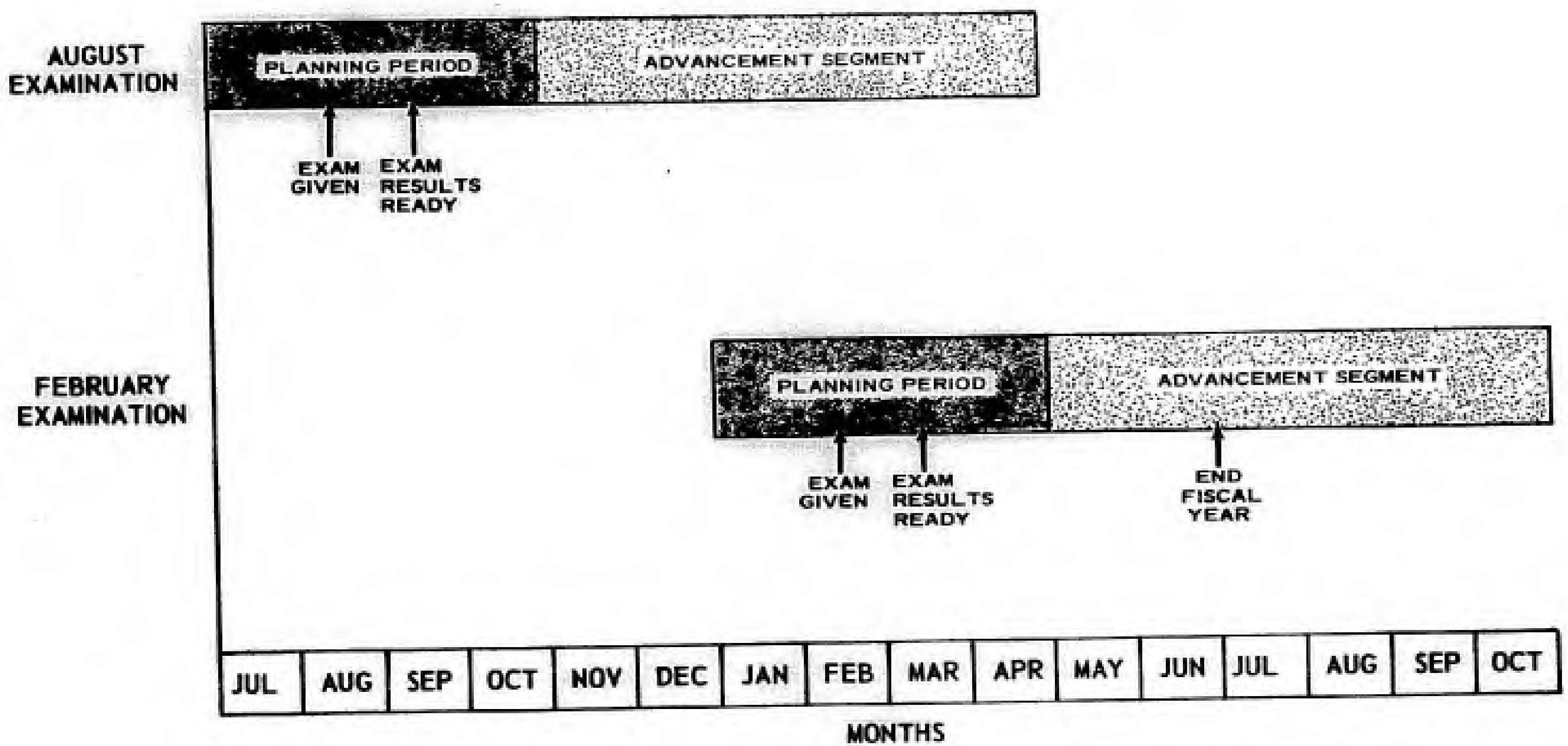
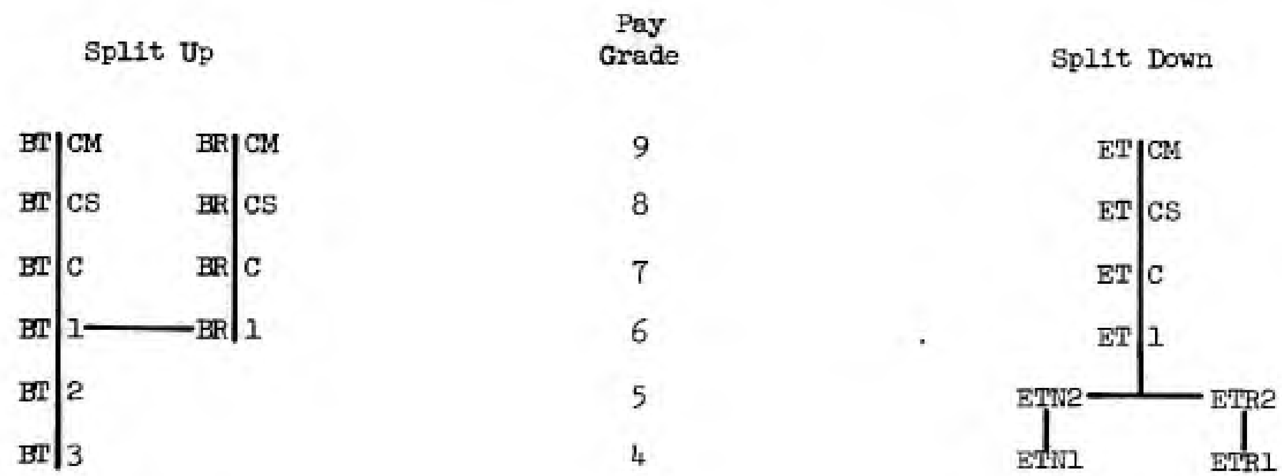


FIGURE 20. ADVANCEMENT COMPUTATION METHOD

Pay Grade	(a) Net Strength	(b) Require-ments	(c) Vacancies [b-a]	(d) Advance Required $[c_i+d_{i+1}]$	(e) Test Passers	(f) Advance In [<d,e]	(g) End Strength $[a+f_i-f_{i+1}]$	(h) Deficit [d-f]	(j) Pay Grade Shortage [b-g]	(k) Excess Passers [e-f]
9	90	100	10	10	15	10	100	0	0	5
8	180	200	20	30	40	30	200	0	0	10
7	360	400	40	70	65	65	395	5	5	0
6	600	700	100	170	150	150	685	20	15	0
5	1700	2000	300	470	550	470	2020	0	-20	80
4	2400	3000	600	1070	870	870	2800	200	200	0
TOTAL	5330	6400	1070	1820	1690	1595	6200	225	200	95

FIGURE 21. TYPES OF RATING STRUCTURE GROUPS



In summary, the fundamental objective of enlisted advancement planning is to select the number of men to be advanced to each petty officer level of each rating so that the petty officer requirements of the Navy are "optimally" met. This process generally occurs twice a year based on the Navy's service-wide advancement examinations given in August and February, as shown in Figure 19.

Advancement Planning Model (ADPLAN)

To assist in this process, research was initiated to study the advancement system, and culminated in the development of ADPLAN (Advancement Planning Model)--a computer program designed to assist in planning the advancement of enlisted personnel in the Navy. The model uses an input of enlisted on board strength, attrition rates, test passers, and requirements; computes predicted vacancies, advancements required, and advancement eligibles by pay grade and rating; and outputs this information in a a form suitable for both analysis and operational use in authorizing advancements. A gross flow chart of ADPLAN is shown in Figure 22.

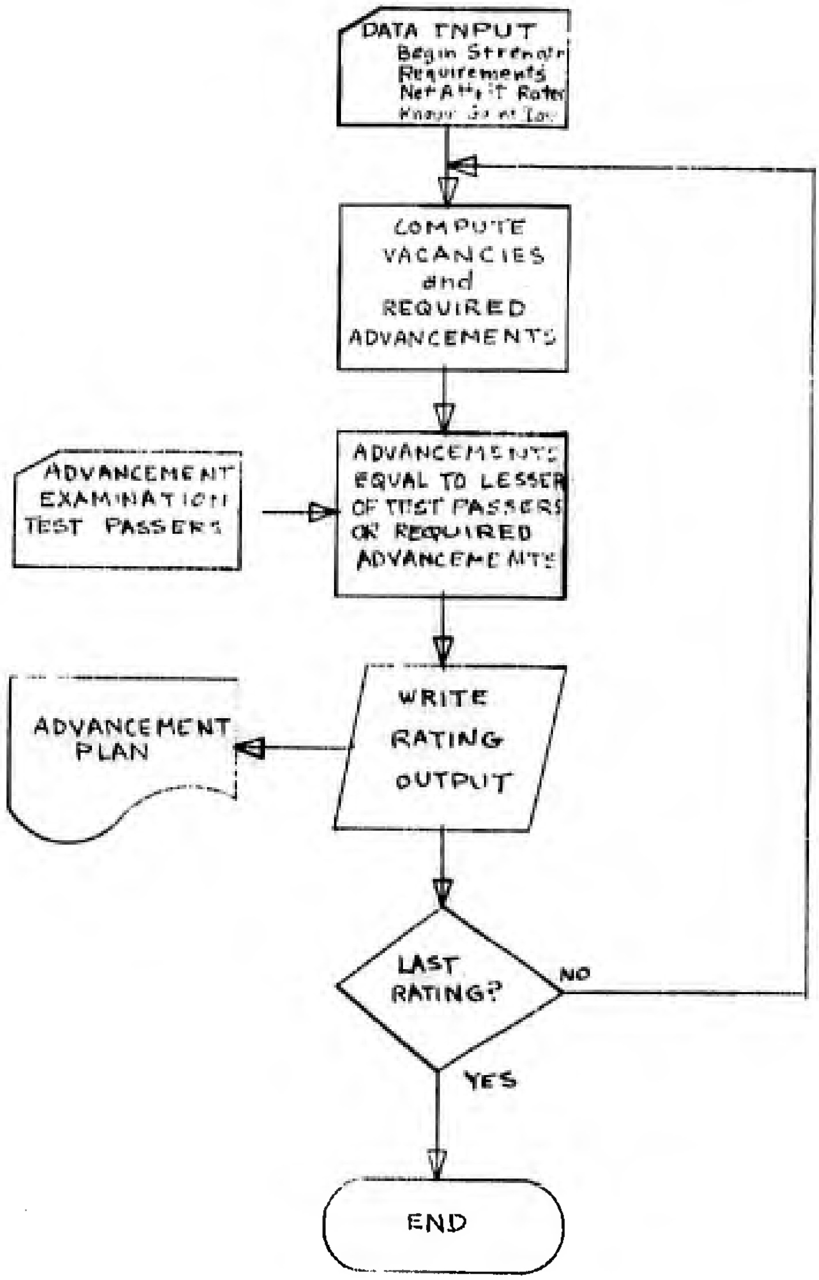
Operational use of ADPLAN to determine advancements, and managerial use to test the effects of different personnel policies on the advancement process, has been ongoing for three years. A forthcoming report will provide a detailed exposition of research on advancement planning systems.

Because advancement planning is performed in terms of meeting manpower objectives, it is important to be able to estimate future advancements as well as plan current advancements. ADPLAN, through use of a projection cycle, not only computes vacancies and advancements required for a current advancement cycle but provides a similar data base for future cycles. This enables the advancement planner to make decisions now to ameliorate or avoid critical problems in the future. As a result, ADPLAN is frequently used for policy testing and for feasibility studies.

Advancement planning must be accomplished in a brief period of time after advancement examinations are scored. Previously, because of the massive computational workload, it was possible to generate only a single plan upon which all advancements had to be based. With ADPLAN, multiple plans may be projected to test the effects of different levels of attrition, changing manpower requirements, changes in personnel management policies, and a myriad of other factors affecting advancements. This enables the Navy to fulfill its manpower requirements through a choice among alternative advancement planning strategies.

Because of the size of the enlisted force, and sheer volume of work in planning advancements for 300,000 to 400,000 petty officers in more than 100 occupational skills at six pay grades, the possibility of errors is high--especially when such planning must be accomplished in a short time frame. ADPLAN automates the calculations necessary to make advancements, thus saving weeks of laborious hand calculation and, even more important, automatically generates highly reliable advancement data with a significant improvement in accuracy.

FIGURE 22. FLOW CHART OF THE ADVANCEMENT PLANNING MODEL (ADPLAN II)



Although ADPLAN is an effective tool for planning advancements, there is no systematic methodology to account for the effect of other personnel subsystems on enlisted advancements or vice versa. For instance, strength planning is constrained by advancements that have already been authorized and, conversely, advancement planning must be constrained by the man year average (MYA) developed in the Strength Plan (which represents the dollar constraint). The latter dictates in which months advancements must occur if a given MYA is to be achieved. In addition, there are interrelationships between advancement planning and grade management, training input planning, career development, recruit planning, and many other flows in the personnel system. In recognition of these interrelationships, and in order to provide enlisted personnel managers with comprehensive, integrated, and computerized tools for personnel planning, the ADSTAP System was developed.

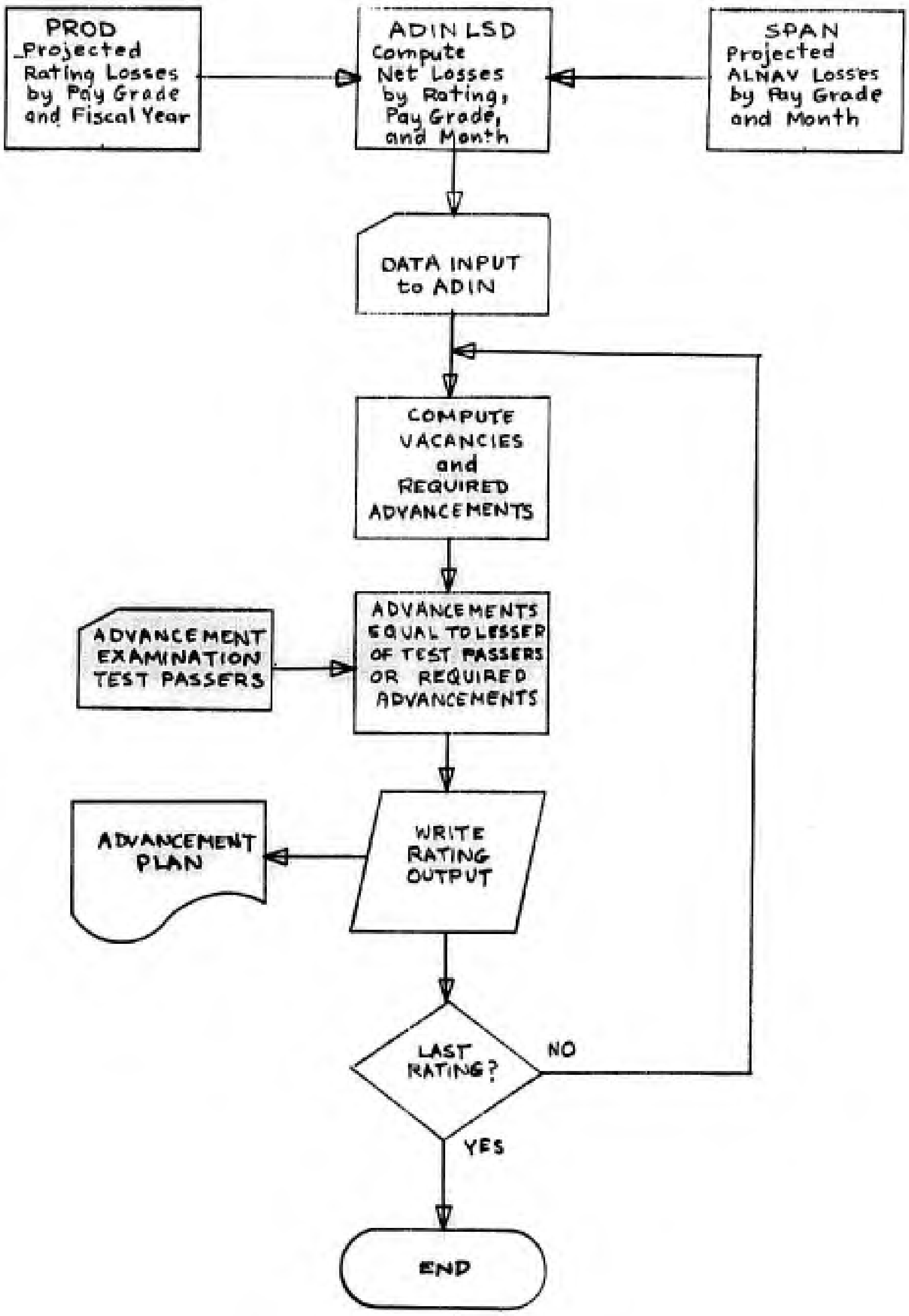
Advancement Interface (ADIN) and Loss Distribution Program (ADINLSD)

Historically, research in advancement planning preceded the design of the ADSTAP System. Now, in order to integrate advancement planning into the ADSTAP System, a successor to ADPLAN is required. In many ways, current features of the ADSTAP System replace techniques formerly programmed into ADPLAN. As a result, the requirement is for an Advancement Interface (ADIN) more than another advancement planning model.

The ADIN program will be designed to provide a computerized capability for selecting the number of personnel at pay grades E-3 through E-8 to be advanced to the next higher pay grade of each rating each month, so that the total Navy monthly strengths by pay grade (as promulgated in the Strength Plan via the SPAN Model), and the end fiscal year strengths by rating and pay grade (as forecasted by the ADSTAP Projection Model) will be attained. This interface will incorporate the constraints of the ADSTAP System within which the advancement planner should work and also provide information currently produced in ADPLAN. This will ensure that all necessary planning data is at hand when the advancement planner determines the number of advancements to authorize by rating, pay grade, and month. ADIN will also provide output of the latest projected monthly strengths, by rating and pay grade, for use by BUPERS Rating Controllers in distributing enlisted personnel. A flow chart of the structure for an Advancement Interface is shown in Figure 23.

As an initial step in the development of the Advancement Interface, a computer program was designed and written for the purpose of integrating output from the ADSTAP System with the requirements of the current ADPLAN Model. This interim program will assure compatibility between ADPLAN and ADSTAP until such time as ADIN is developed. The Advancement Interface Loss Distribution program (ADINLSD) accomplishes this integration process by computing monthly net losses using input from PROJECT in the form of projected gains and losses by year for each rating, and input from SPAN in the form of projected gains and losses by month for the total Navy. Computationally, this program produces a matrix array from side and bottom vectors by multiplying corresponding cells and scaling by the sum. The resulting net losses by month for each rate, when used in ADPLAN, ensure that the prediction of vacancies is common to both advancement and strength planners and is consistent with the operation of the ADSTAP System.

FIGURE 23. FLOW CHART OF ADVANCEMENT PLANNING INTERFACE (ADIN)



If advancement planning with ADPLAN were accomplished outside of ADSTAP System constraints, the results could be very detrimental to the success of personnel management objectives and policies, and could easily be unresponsive to budgetary considerations. ADINLSD is a major step toward avoiding such problems, while assuring maximum management flexibility in planning enlisted advancements.

Although the immediate objective of all these advancement planning techniques is the provision of a force of petty officers sufficient to accomplish naval missions within the constraints of cost and manpower requirements, there are personnel management considerations of a long-term nature which these programs can also help to attain. Another ADSTAP subsystem which deals with such personnel management goals is outlined in the following section. It is termed Grade Management program or GRAMP.

Grade Management Planning

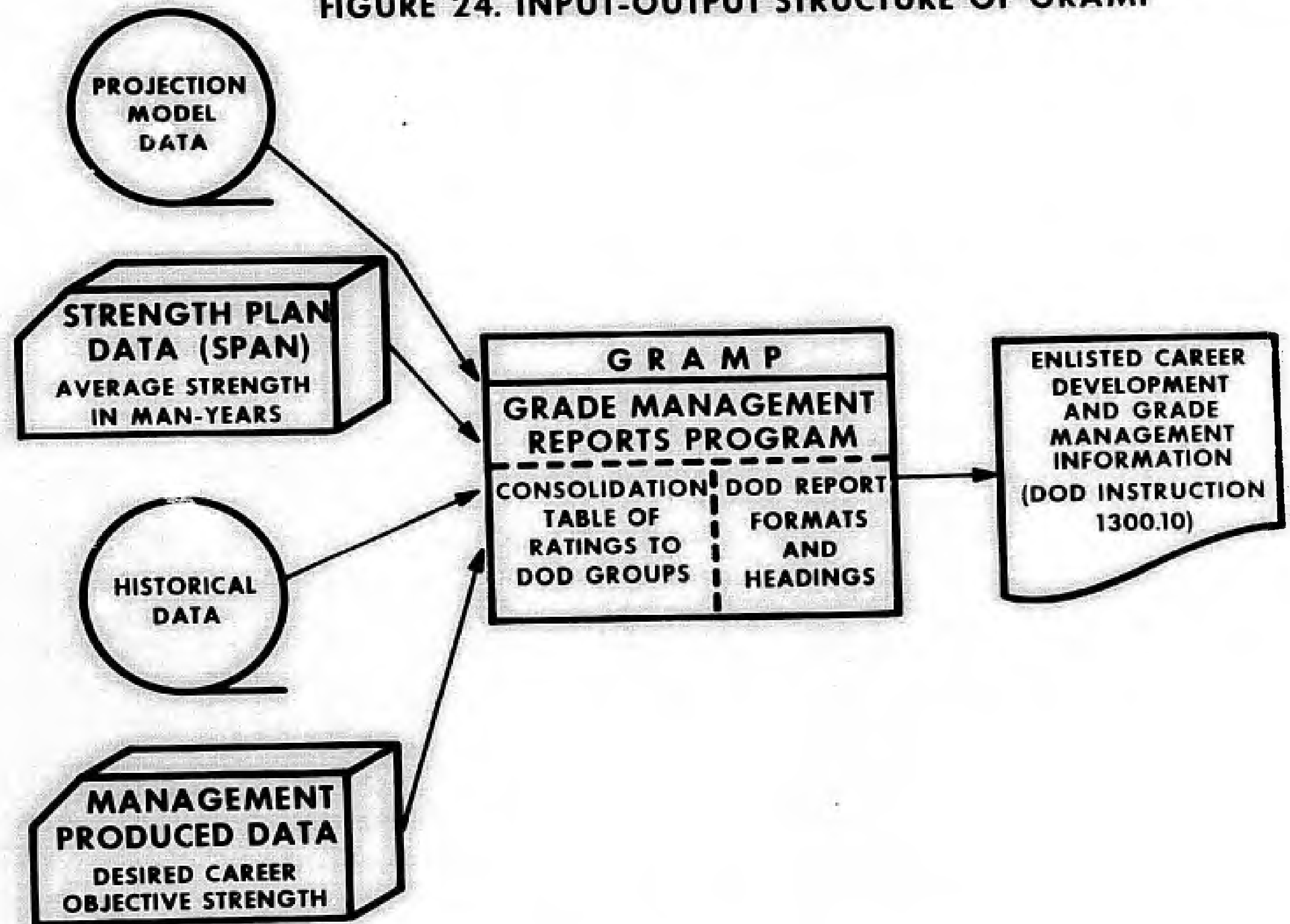
This abbreviated section is devoted to a description of the only element in the ADSTAP System's planning programs and models whose use is routine. In order to generate certain required historical and projected manpower information for the formulation of naval enlisted personnel management objectives, a computer routine called the Grade Management Program (GRAMP) was developed. This information provides the basis for measuring progress toward achieving mutually agreed upon career development objectives between each service and the Director for Enlisted Manpower Management Systems, Office of the Assistant Secretary of Defense (M&RA). These objectives include career progression, promotion opportunity, and top six enlisted grade ratios in the DOD occupational specialty areas or SROFs (self-renewing occupational fields). The information generated by GRAMP is contained in a series of formats, some of which provide projections of strength, gains, losses, and promotions in future years to assist management in evaluating objectives and defining real or potential problem areas. In addition, the output of this program fulfills most of the requirements of DOD Instruction 1300.10--which establishes the need for an Enlisted Grade Management Program in each of the services.

This computer program is a by-product of the ADSTAP development effort and has been fully implemented for use by BUPERS planners, where the program will be maintained. Figure 24 provides a flow diagram of the input-output structure of GRAMP. It should be noted that outputs from the ADSTAP System (such as the Projection and Strength Planning Models) are essential to the development of the information required by DOD. Because GRAMP produces both historical and projected information, an additional computer program was necessary to extract, format, and output historical data in a manner acceptable to GRAMP--and for obvious reasons this program was dubbed GRIST.

Although GRAMP performs many computations, it is essentially a management information program which aggregates, formats, and otherwise arranges data for subsequent analysis and evaluation. The importance of GRAMP lies in its function as an information interface between the ADSTAP System and the role of the Department of Defense in reviewing the various services' grade management and career development programs.

In the latter regard, one of the most important methods of achieving career development objectives--aside from those implied in the previous section on advancement planning--is through the Navy's system for recruitment, classification, and initial occupational training. The following section on recruit allocation and training input models considers some of the crucial aspects of force management.

FIGURE 24. INPUT-OUTPUT STRUCTURE OF GRAMP



Recruit Allocation and Training Input Planning

Problems in Planning Rating Input

One of the more interesting problems in managing the personnel system is that of assuring sufficient input to each rating at the petty officer level. More specifically, the problem is to provide adequate numbers of non-rated and striker personnel at the E-3 level, and at the right time, so that a sufficient reservoir of personnel will be available to take and pass the advancement in rating examination, and become eligible to advance to petty officer status in the various ratings. Although the problem may seem straightforward and amenable to solution, on closer examination it becomes a good deal more diffuse and interactive with other components of the personnel system. For instance, an investigation of the non-rated base necessary to support the petty officer structure inevitably gets into the area of the size, quality, and phasing of recruit input. But even given a particular configuration of recruit input, how should these personnel be allocated to Navy career paths or ratings? Should the allocation be on the basis of current needs or future needs, or both? Are short-range and long-range needs compatible in terms of a single recruit input and rating allocation strategy? How many should be school-trained inputs and how many should advance to E-4 via the on-the-job training route? Should all recruits advance to petty officer at the same rate, and if not, what should the flow be for each rating? Should some ratings command a disproportionate share of the higher GCT levels of the recruit population? How many apprenticeship groups should there be to effectively train and supply input for over 100 ratings?

Even after answering some of the above questions, there are other problems related to feasibility. For instance, is it even possible to recruit sufficient personnel at an adequate level of quality, and at the precise time they are needed to meet a given set of petty officer objectives? Is it possible, or even desirable, to fill petty officer vacancies with the smallest possible input at the fastest time possible? Can the training plan be increased or decreased at a rate consistent with fluctuating needs for petty officers? And if not, what is the break-even point in establishing new or expanded training facilities or reducing them? These, and many other questions are all problems relating to the task of planning for sufficient input to the force of petty officers. Among other reasons, the task is complicated because of the number, variability, and needs of the ratings themselves, and the implications of the time dimension.

To deal with these problems, research has been initiated on multiple "fronts." Basically, the objective is to design techniques to assist in making decisions regarding the number of recruits that should be input <u>now</u> to meet some petty officer objective in the <u>future</u>, given the state of the pipeline and a wide variety of policy constraints and trade-offs. Among other requirements, in order to advance to E-4, enlisted personnel must be technically prepared either through formal school training (usually A-school) or through "on-the-job" (OJT) training. Because of this, the question of training input--at least for A-school--becomes a subset of the more general problem of recruit allocation.

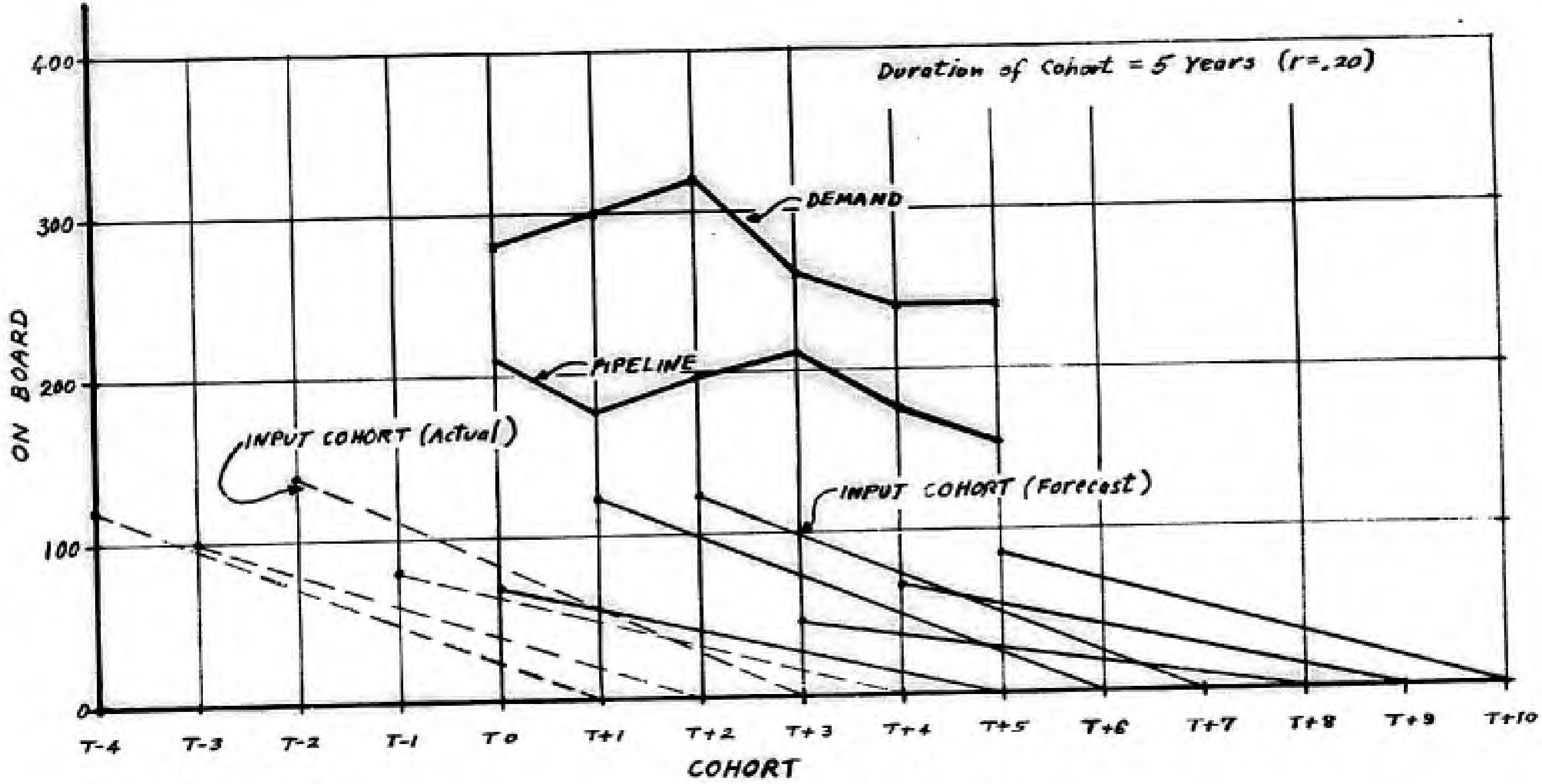
To illustrate the problem of determining the number of recruits necessary to "feed" the various ratings, Figure 25 shows a conceptual model for planning recruit input based on a simple replacement mechanism. Several considerations are involved: (1) recruit input in previous years which, at any given point in time, can be summed to produce the pipeline; (2) a demand function which specifies the base population necessary to sustain the petty officer structure currently and each year in the future; and (3) the expected duration of a given recruit class or "cohort"--that is, the ultimate period of time that a cohort member will remain in service. If one assumes the decrease in size of a given recruit class over time--due to attrition out of the service or advancement out of the base to petty officer--is linear with respect to time, then a cohort duration of five years will produce a .20 "decay" rate.

In Figure 25, four previous recruit classes of 120, 100, 140, and 80, each with a "decay" rate of .20, produced a pipeline of 212 at To. The recruit input (68) necessary to fill the base at To is simply the demand (280) minus the pipeline (212)--hence the term replacement. Adding the To cohort to previous cohorts at T-1 through T-4 allows the process to increment one more year. The computations at the bottom of Figure 25 illustrate the results of running this replacement model over a period of five years.

The Model described above is illustrative of the fundamental problem in planning recruit input, but should in no sense be taken as a serious proposal for solving the problem. Indeed, the Model cannot begin to solve the problem because it represents a grossly oversimplified version of what is really necessary in modelling the problem. For example, the "decay" rate is assumed to be strictly linear over time although there is no empirical basis for that assumption. In fact, the idea that a cohort is exhausted in five years is itself fallacious in the face of obvious reenlistments. Of any annual cohort = 100, it could be expected that at least one would "survive" to retirement. One could, with sufficient time and data, quantify the curvilinear properties of the decay rate--recognizing that they vary from rating to rating, and may also vary over time even for the same rating.

This Model must be provided with a projected "demand"--that is, bottom-three strength necessary to support a given petty officer force. Since the determination of that number is precisely one of the "nasty" questions involved in recruit allocation, the model is seriously lacking in this regard. This, however, could be overcome in part by specifiying the demand function in terms of projected vacancies, test passers, predicted losses, etc.--all of which are available as Projection Model outputs. More serious is the assumption that intra-year demand is constant when in fact it not only varies from month to month but reflects a strong "seasonal" effect. For instance, one of the greatest drains on personnel in the bottom three pay grades is the advancement system, whereby E-3 personnel become petty officers in two substantial increments each year--the phasing being determined by results of the February and August advancement in rating examinations.

FIGURE 25. A SIMPLIFIED REPLACEMENT RECRUIT INPUT MODEL



DEMAND					280	300	320	260	240	240
PIPELINE					212	178	198	213	172	154
INPUT	120	100	140	80	68	122	122	46	68	85

There are a number of other criticisms which might be levelled against this Model but they would be pointless. This is because the above discussion was not intended to show limitations in the solution; instead, its purpose was to illustrate some of the complexities involved in any solution.

One of these complexities is tied to the necessity for managing the Navy's enlisted force in terms of the individual ratings and their assorted characteristics. The total Navy is, after all, the sum of its many parts. And although there are interactions between total Navy objectives (such as authorized strength) and individual rating objectives (such as career development and advancement), the sum total is more a result of personnel actions taken in terms of rating management than the reverse. For instance, recruit classification, A-school input quotas, enlisted advancements, Variable Reenlistment Bonuses, and Pro Pay costs, incentive programs to induce movement from surplus to shortage ratings (SCORE and STAR programs), the "open rates" list, distribution-assignment-detailing and rotation, and a large number of other personnel actions are most often the result of attempts to sustain a "healthy" inventory in the various naval occupational specialties.

Another way of looking at this problem is provided in Appendix B: A Steady State Model for Determining Rating Input. Although it suffers from some of the same criticisms as the Replacement Model, it is included as an addenda because of its approach to the problem.

One of the major difficulties in researching the problem of rating input is the instability of the force structure in the lower three pay grades and the "younger" length of service categories. The flows in this quadrant of a force structure matrix are not only fast but extremely fluid. Nevertheless, it is difficult to approach the problem of resource allocation without a good knowledge of the way in which the system flows its recruits up to petty officer, by rating and over time.

It should be noted that the problem of discovering the flow of personnel through a force structure is considerably more complex in the bottom three pay grades than for petty officers. This is because the rate of flow from pay grade to pay grade is much faster than in the top six pay grades, in that multiple grade movements can and do occur in a single fiscal year. Also there is a wide differential in the flow rate between ratings, that is, the time it takes an average recruit to reach E-4 in one rating vice another. In addition, new input into the Navy does not always enter at pay grade E-1, nor does it always enter at the bottom in terms of longevity. Reserve input, especially, normally enters at E-2 and above, and with at least one year's experience (as measured by Pay Entry Base Data). Tied to the difficulty of describing non-rated flows is, of course, the problem of recruit allocation. That is, how many recruits should be allocated to each rating in order to meet future petty officer requirements?

Bottom Three Simulation (LOFLOW) and Training Input Optimizer (TRIO)

Because of the problems involved in describing non-rated flows, research in this area is employing the simulation approach. In this regard, a computer model is being designed to simulate bottom three movements of personnel by length of service and rating in order to test different flow methodologies and recruit allocation algorithms. This program is called LOFLOW, and will eventually be incorporated in the Projection Model as a subroutine to accommodate recruit, apprenticeship, and striker projections and serve as the medium for testing different rating input strategies. By itself, LOFLOW is not designed to "optimize" or "solve" recruit allocation problems. It is intended to be able to simulate the results of such allocations in terms of the total enlisted personnel system.

Concomitant with the development of LOFLOW is another research effort devoted to optimizing, within a set of formidable constraints, the allocation of recruits to ratings. As noted previously, a subset of this problem is the task of planning A-school input and OJT input in such a way as to provide sufficient trained resources for input to the ratings. This research is expected to culminate in the development of a computer model termed Training Input Optimizer (TRIO), which will mathematically determine the "best" allocation of men to each rating (or as a variant, each A-school) at a given point in time.

As envisioned in TRIO, under a set of constraints an "optimum" allocation of recruits to a rating at time t_i will be based on a demand function (in the form of loss behavior) at t_{i+n}, given a specified flow rate (in the form of length of service parameters). The set of constraints may be concerned with the size, phasing, and yearly variability of recruit input as well as various properties of rating flow. One of the major results expected from use of TRIO is the capability to determine the effect of optimal recruit input, training input, and flow rate strategies on meeting future petty officer requirements. Similarly, TRIO, in concert with LOFLOW, should be able to determine the effect of such strategies on the personnel system itself. This tandem is important because an optimal recruit or training input allocation in its own terms, may not be optimal in terms of the manpower budget, advancement policy, or some other criterion.

Fundamental to the development of computer models such as TRIO and LOFLOW is a research effort devoted to the substantive investigation of the Navy's non-rated population. For instance, a central consideration in the A-school input planning process is the identification of non-rated personnel in terms which will permit their allocation to the career force. Among the problems intended for study is that of the apprenticeship concept itself; that is, what function a naval apprenticeship should perform; how many apprenticeships there should be; how many pay grade levels should each occupy; how large an apprenticeship group is necessary to support the ratings or career fields involved; what is the optimum ratio between apprenticeship groups and journeyman levels; how apprenticeship groups are advanced; and how they are trained. Until such time as apprenticeships are aligned more specifically with individual enlisted careers, there must be some method of identifying the non-rated population from which enlisted personnel advance into their respective career fields. The individuals who are officially designated strikers by virtue of their having graduated from A-school, passed the E-4 examination, or been reduced from a higher pay grade, present no problem in this regard.

In LOFLOW, one technique will be to apportion non-rated personnel by rating according to historical rating E-4 advancement examination taker/passer experience. The history necessary to develop this methodology is contained in this Laboratory's files of historical advancement examination data, although considerable processing is still necessary to extract such data in a useable form. Whether this historical allocation is sufficient to meet future petty officer requirements could be easily determined by TRIO.

A further area for investigation is the feasibility of mathematically describing the flow of recruit input through pay grades E-2 and E-3. The rate at which personnel progress to E-4 varies between ratings, as well as between A-school and non-A-school personnel within a single rating, and considerable effort will be directed toward defining these differences. Ideally, a series of specific analyses should be undertaken to provide information which will "track" recruits from their initial entry into the Navy through their advancement to rating or designation as a striker. Such a procedure is frequently referred to as "cohort analysis." This involves a comprehensive examination of the flows of personnel into the Navy, through recruit training, through A-school or on-the-job training, and into a rating. Each step must be analyzed to determine the net attrition that can be expected from these flows. Again, the necessary data are available but as yet unprocessed. Obviously, research with the purpose of describing A-school and rating input to meet future petty officer vacancies, and planning present recruit allocation strategies, has direct payoff for the development of both LOFLOW and TRIO. The movement of personnel from recruit to petty officer can be considered both an objective of and a constraint on, the training input process.

Currently the design parameters of TRIO are being developed and the resources are available for building a mathematical structure to encompass the optimization problem. LOFLOW, being a more data dependent research effort, is proceeding at a somewhat slower pace because of the time and cost involved in large scale data manipulation.

Providing sufficient A-school input in order to meet future petty officer requirements helps to <u>generate</u> a career field which results in an adequate arena for career development as well as meeting the Navy's manpower requirements. In order to <u>maintain</u> a career field in "healthy" condition and provide for the specific skills required to man the Navy, it is necessary to carefully plan C-school input as well.

<u>C-School Input Planning (COOL)</u>

A basic problem for C-school planning involves the determination of the "best" ratio of school output to fleet skill requirements. Because of changes in personnel attrition, operational commitments, and overall personnel management policy, fleet requirements for skilled personnel can often change radically and unpredictably. As a consequence, at any given point in time school output may not be appropriate to fleet needs. In one case, too low an output can result in billets remaining vacant or being filled by personnel without the needed skills. On the other hand, if school output exceeds fleet needs, personnel may be assigned to billets where their specialized training cannot be utilized. The research effort in this area will be directed toward providing the C-school planner with the information and analytic techniques necessary for effective coordination of school output with fleet manpower needs through use of a more flexible quota system for school input.

The key factor in the design of an improved planning system involves determining how the dynamic character of fleet personnel needs can be detected and communicated to the C-school planner so that a compensating change to school input can be determined. To make his decisions, the C-school planner must also have information about the ratio of school input to output in terms of failure rates, attrition, school sitters, and so on. Information describing the manpower pool from which the school input will be drawn must also be available. In order to most efficiently utilize this information, the research will seek computerized, mathematical techniques that will permit the detailed analysis of data and decision alternatives.

Research to develop a C-school Input Program (COOL) is anticipated to begin as soon as data and resources are available. The final end products of this research will enable C-school planners to have a better long-range control over the training flow while, at the same time, having the ability to respond quickly to fleet requirements when needed. As a first exploratory step in this direction, the Bureau of Naval Personnel, through the Assistant Chief for Plans and Programs, has just initiated a feasibility study.

Whether the problem is recruit allocation or training input planning, the management task is so large and characterized by so much inter-rating variance, there must be some measures by which ratings can be compared. It is precisely this problem that the next section addresses.

An Approach to Policy Evaluation

Computer-oriented techniques to assist in the development and evaluation of personnel policies are presently undergoing research as a major component of the ADSTAP System. The impetus for this research was the need to reduce and synthesize the staggering volume of information generated by the Projection Model, and display such information in a form suitable for managers to easily grasp the significance of Projection Model results. While engaged in this effort, it became increasingly clear that a computer program which aggregates and synthesizes data might also serve as a vehicle for the systematic evaluation of personnel policies, as they are reflected in Projection Model output. Accordingly, the first attempt was labelled, somewhat grandiloquently, the Policy Planning Program (POLIP).

As noted previously, PROJECT models the operation of the personnel system as it is affected by the personnel planner's input. The conditions under which the Projection Model operate are determined by the planner, and called a "policy set." The latter simply refers to a group of program controls and pre-determined quantities that are input for a particular run of the Projection Model in order to determine the probable effect of policies as represented by those controls and numbers. Policy testing is, of course, one of the primary purposes behind the development of the ADSTAP System. The approach in POLIP proceeded along the following lines.

If a personnel planner wanted to determine the effect of increased requirements on average length of service (LOS) in a given rating, the higher requirements would be input to PROJECT and a computer run would be made. Output would consist of a series of 9 x 31 force structure matrices for the starting on board population, advancements, and the end inventory. With 279 cells of data in each matrix, the planner would have to calculate the arithmetic mean for each pay grade of each matrix to determine if any change in mean LOS occurred. Once having made these calculations, further questions would inevitably arise as to the relationship of those means compared with other ratings or the total Navy. As a result, many comparisons and calculations would have to be made before the initial analysis could be completed. Similarly, the same kind of difficulties arise in attempting to evaluate other characteristics of a force structure, such as measures of promotion opportunity, petty officer ratios, career ratios, shortage/surplus indices, and others.

In order to evaluate the effect of various policies in some systematic and economical manner, it became necessary to measure various attributes of the force structure matrix. It was obviously preferable to characterize a force structure by a few statistical measures that expressed its "essence," rather than try to evaluate the entire 279 cell matrix visually. Consequently, and from this foundation, research proceeded in the area of policy development and evaluation.

Policy Planning Program (POLIP)

Fundamentally, the purpose of POLIP is to facilitate the process of evaluating the effects of alternative personnel policies in order to assist planners in defining and achieving a desired force structure. POLIP operates on a projected or historical data base consisting of length of service by pay grade matrices. This is accomplished as follows. The Policy Planning Program uses a data file produced by PROJECT as the primary input. Based on projected personnel inventories and changes to those inventories, POLIP computes a selection of force structure parameters which provides information necessary to evaluate specific policies or policy sets.

The interface between PROJECT and POLIP is diagrammed in Figure 26. A special program--POLIP Interface or POLIN (3)--reads the magnetic tape output (2) from the Projection Model (1) and creates a data file (4). In accomplishing this, POLIN generates a random-access, index-sequential form of file on disk for on-line use by the POLIP program (5).

Once the data file has been created for a particular forecast (i.e., a specific run of the Projection Model), the repeated use of this file, as control options and management criteria are varied, does not require a re-running of POLIN. This process is shown in Figure 26 as the feedback loop (6). It is anticipated that this will be the most frequently used path when a particular forecast is analyzed in detail by use of POLIP. A second feedback loop (7) returns to the Projection Model when new policies are tried and a different projection is output. In this case, POLIN must again transfer data from tape to disk in the appropriate form so that a new series of POLIP runs can be used to analyze the newly projected effects of personnel policies.

Briefly, POLIP formats output matrices from PROJECT and calculates a spectrum of statistical measures or indices which summarize, define, and evaluate different characteristics of the force structure. Among these measures are mean time in service, variance, median, petty officer ratio, grade ratio, career ratio, promotion opportunity indices, and others, as shown in Figure 27. In addition, the program "flags" situations which are exceptional; that is, values which exceed the limits of an acceptable range.

In the current version of POLIP, the user may specify what indices are to be measured, and for which matrices or variables that are output from the Projection Model. He may also specify either of the above for any or all ratings and any or all years of projection. In addition, the user of POLIP can set limits (sometimes referred to as management criteria) for any of the indices and control the type of output--either total display of all information, or "flagging" values which exceed the management criteria, or only printing the exceptions, as shown in Figure 28. In short, POLIP provides tools for analyzing force structure projections by (a) summarization using totals and proportions, (b) statistical description through the computation of various measures, and (c) evaluation of those indices through the use of management criteria or force parameters. Further details on the structure of POLIP are contained in a forthcoming report.

FIGURE 26. PROJECT - POLIP INTERFACE

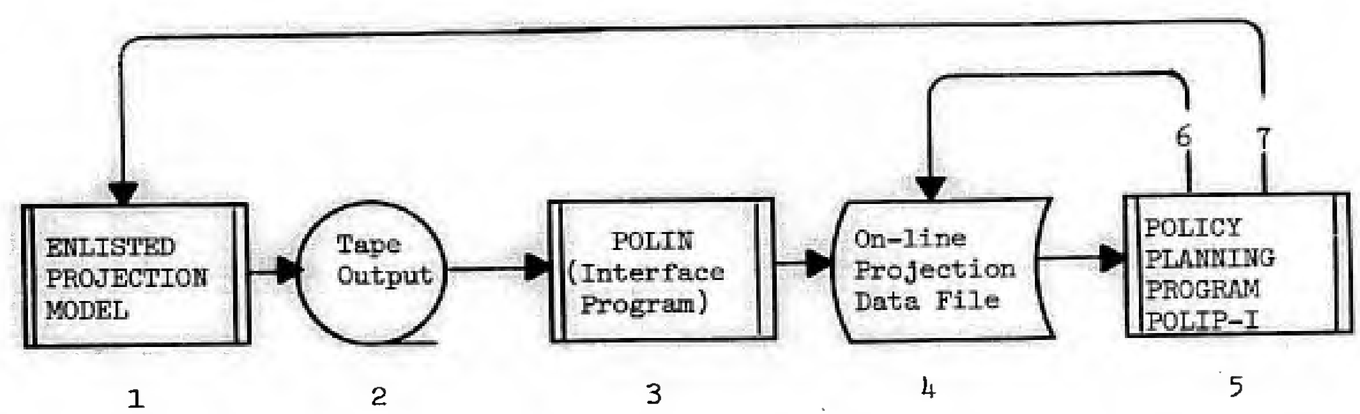


FIGURE 27. FORCE STRUCTURE INDICES

MEAN, LENGTH OF SERVICE

STANDARD DEVIATION, LENGTH OF SERVICE

GRADE PROGRESSION INDEX

PROMOTION OPPORTUNITY INDEX

RATING SHORTAGE INDEX

RATING CRITICALITY INDEX

COST INDEX

UTILITY INDEX

PAY GRADE RATIO

PETTY OFFICER GRADE RATIO

PETTY OFFICER RATIO

CAREER RATIO

FIGURE 28. TYPICAL POLIP OUTPUT

INPUT DATA

MANAGEMENT CRITERIA MEAN LOS

	E1	E2	E3	E4	E5	E6	E7	E8	E9
UPPER	2.0	2.5	3.5	4.5	8.0	13.0	18.5	20.5	22.5
LOWER	1.0	1.5	2.5	2.7	5.5	11.5	15.5	19.5	21.5

OUTPUT

MEAN LOS FLAGGED DISPLAY

E1	E2	E3	E4	E5	E6	E7	E8	E9
1.1	1.2MC	2.9	3.5	8.0	13.4MC	17.7	20.1	22.5

(MC) INDICATES VALUE OUTSIDE OF MANAGEMENT CRITERIA RANGE

MEAN LOS MANAGEMENT BY EXCEPTION DISPLAY

(ONLY EXCEPTIONS TO MC ARE DISPLAYED)

E1	E2	E3	E4	E5	E6	E7	E8	E9
	1.2				13.4			

Future Developments

Although the first version of POLIP has been operationally implemented, there is a considerable amount of future research and development needed in policy planning programs. At least four major areas are under consideration:

1. Control Language (CL). In the current program (POLIP-I), the operator (a) selects the ratings and variables (or arrays) to be the subject of various statistical measures (or Force Indices); (b) determines the acceptable limits (or Force Parameters) of the indices selected; and (c) determines the output mode to be employed. Requests for output are organized around ratings in this version of the Control Language--termed CL I. There are a number of editing features written into CL I which result in defaults and/or error messages as appropriate. In a more advanced Control Language, the Force Parameter itself will become the central concept for organizing data and increased power will be written into the CL so that the same policy set may be applied to all ratings or all arrays or some subset--without specifically generating option code for every element in the set.

2. Force Indices (FI). In POLIP-I, there are two varieties of force structure measures: (a) measures which can be applied to a variety of arrays for a variety of ratings, such as "mean LOS" or "petty officer ratio" applied to inventory or advancements for the BM or ET rating; and (b) measures which define the variables or arrays required for the calculation and therefore permit no option, such as "promotion opportunity"--which obviously employs advancements for its computational base. A number of developments are planned in the use and computation of Force Indices. For instance, it is feasible to employ measures which evaluate the statistical significance of and among means. In addition, an FI library can be designed in such a way that new FIs may be defined and entered into the library via control statements, rather than program code, by the user himself.

3. Force Parameters (FP). The current FP capability allows the user to establish upper and lower limits for each Force Index in order to generate management-by-exception output. A number of major enhancements are planned in this area. First, methods will be developed to allow the value of one measure to automatically set the limits for another during the same computer run. For example, the standard deviation of a length of service distribution can become the FP for the mean without the user employing multiple runs or developing the criteria himself. Another example is the case where the total Navy petty officer ratio ± 10% would become the FP for each rating's petty officer ratio. Significance levels or confidence limits can be computed for some indices as well. Also, multiple criteria could be applied to the same array in the same computer run. There are many other enhancements possible in the area of management criteria that await further research and development.

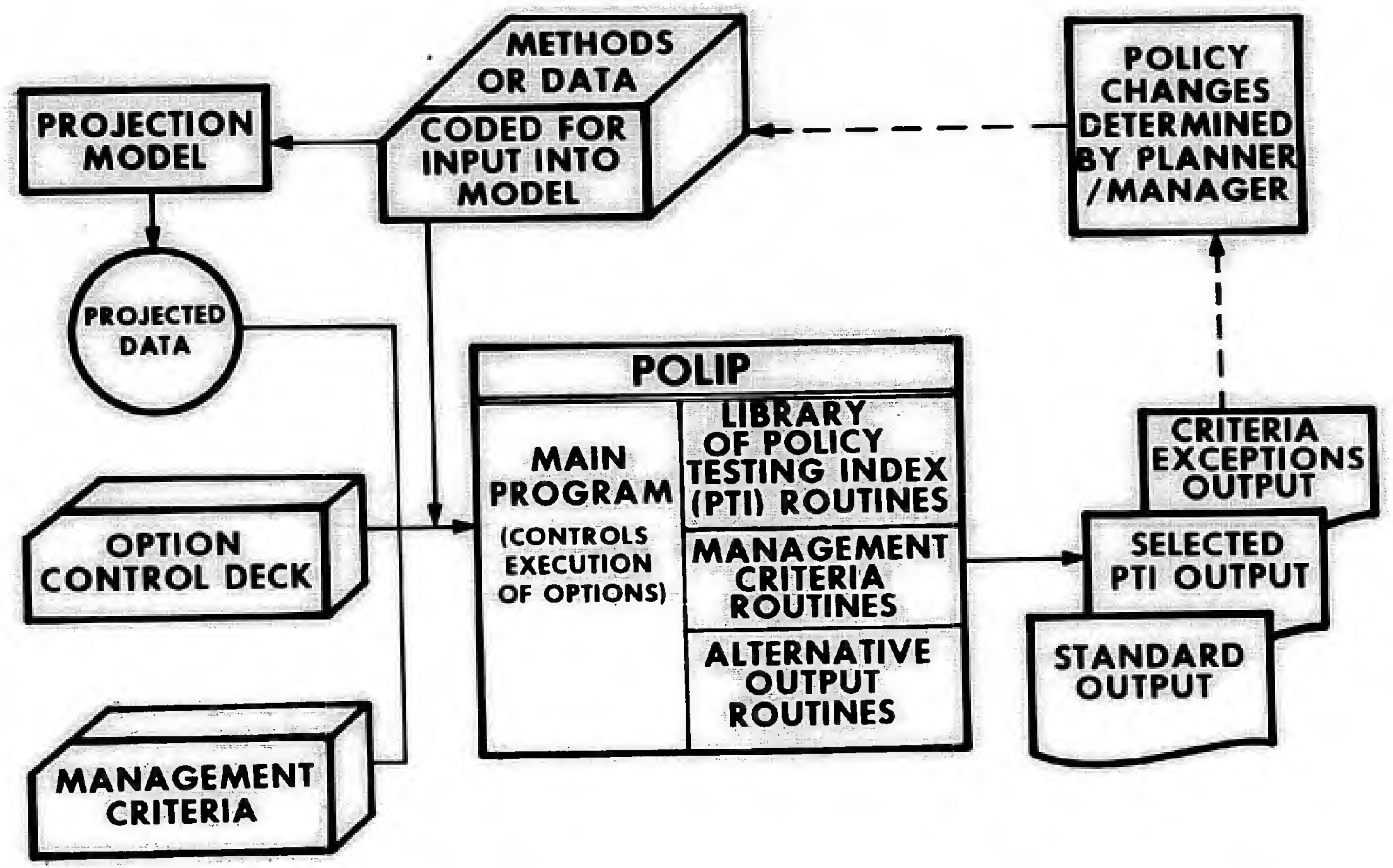
4. Output. Three choices are available in output control for users of POLIP-I: (a) complete output with no management criteria or limits designated; (b) complete output with exceptions to Force Parameters (values above or below the limits defining an acceptable range) flagged on the listing; and (c) output containing only those values which are exceptions to the FP. Anticipated program developments will provide for FP to be printed along with the related FI in the same format. Special listings of "exceptional" ratings will be printed, such as all shortage and all surplus ratings. Ultimately, histogram and plotter outputs will be provided as a more succinct form of management information.

In addition to the above, an advanced version of POLIP is being designed to close the interface between POLIP and the ADSTAP System's Projection Model so that different policy sets may be evaluated and modified by POLIP for feedback to the Projection Model. Figure 29 illustrates such a relationship.

Recapitulation

The Policy Planning Subsystem of ADSTAP described above completes that component of the System referred to as Planning Programs and Models. The latter represents the third major component of the ADSTAP System, whose first two components--it will be recalled--were the Planning Data Base and Projection Model. In the discussion to this point, over twenty computer programs or models were described in terms of both present and intended capabilities. However, in order for ADSTAP to become a system, some method of linking these programs within and between the three basic components must be provided. Efforts along this line are described in the following section.

FIGURE 29. POLIP-PROJECT FEEDBACK SYSTEM



SYSTEM INTERFACE

There are at least two major classes of problems in organizing a system as large and complex as ADSTAP: one involves the management of computer programs and the other concerns the management of data sets. Because of the number of programs in the System and the number of options or controls in each program, for all practical purposes there are an infinite number of combinatorial paths through the System. Thus, one kind of systems problem involves the interface between programs.

Program Interface

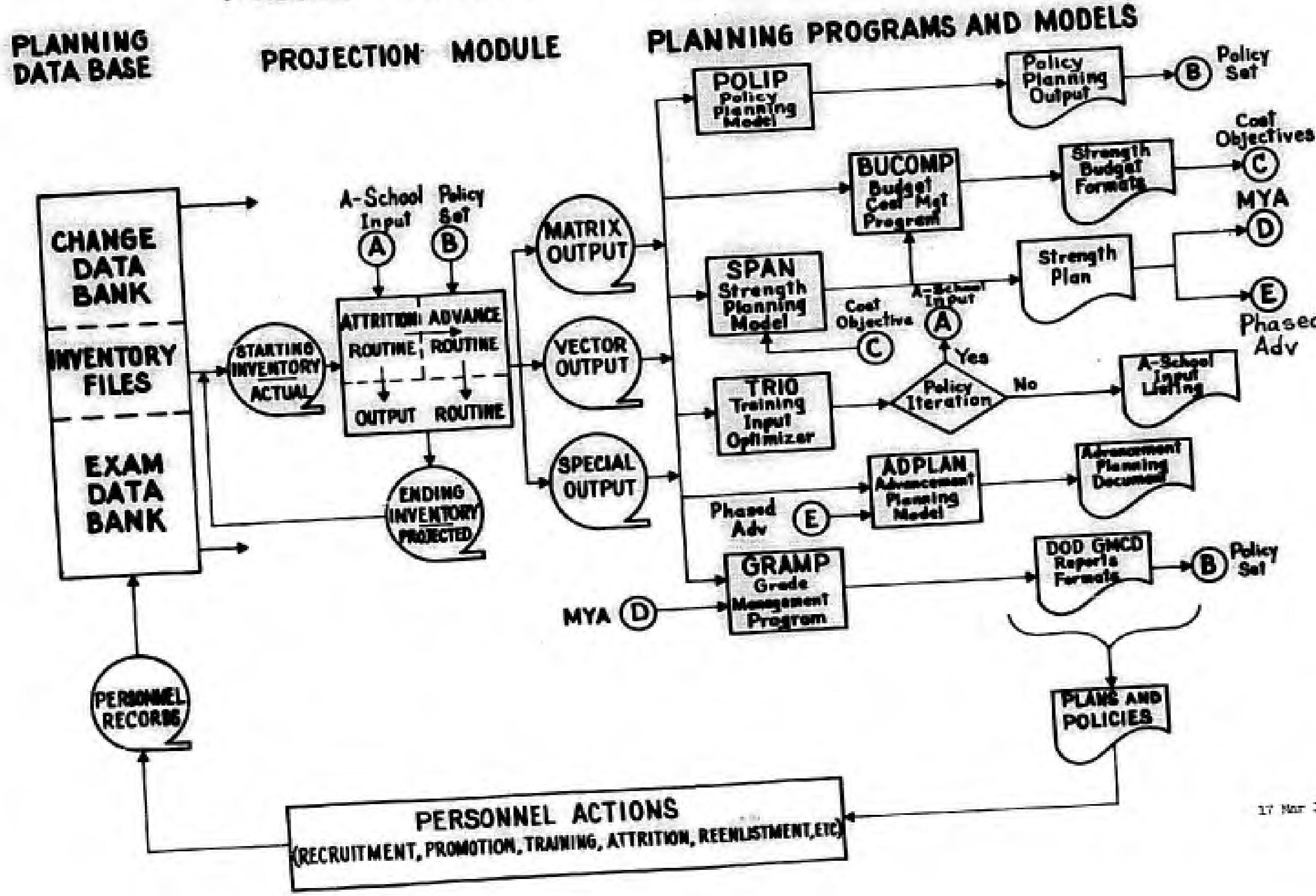
Any system consisting of a set of computer programs whose interfaces include manual effort has an inherent responsiveness limitation based on turnaround time at the subject installation multiplied by the shortest path through the system in number of programs. Finding the means for escaping this limitation has long plagued system designers, yet its solution is seldom trivial. One possibility is a control program which calls upon modules of the system in some sequence determined either externally or internally to the control program, and which manages or monitors inter-communication between those modules. In some cases this works admirably, but it assumes that certain design criteria have been maintained within the working modules and further assumes extensive capabilities on the part of an operating system. Frequently, such control programs operate at a considerable overhead in computer system resources and are therefore expensive and cumbersome. At present, it appears that the state-of-the-art in operating systems is such that constructing a control program for the ADSTAP System would be difficult and that the efficiency of the result may leave something to be desired.

An alternative approach, one quite compatible with the design of Ø/S 360, could take the form of a preprocessor which examines a request for information from the System, and tailors a job stream (a set of control images and data for an operating system) calling for those programs and data management services required for satisfaction of the request. The job stream thus generated can be fed almost directly to the operating system, resulting in considerable responsiveness. The system/360 assembler is well suited to assist in the generation of such job streams and could greatly simplify the interface problem. Even so, the management of programs is only one part of the problem; a second class of interface problems is concerned with the management of data sets.

Data Set Interface

Figure 30 illustrates the ADSTAP System interface in terms of data flows between programs. Although this chart is oversimplified, it does give some idea of the specific data inputs and outputs required by the various programs and components of the System. Managing such data flows presents another problem for the System Interface.

FIGURE 30. ADSTAP SYSTEM INTERFACE



17 Mar 1970

In any system such as ADSTAP, which is made up of a number of components that both feed data to and require data from other programs in the System, the interfacing of programs in the System to satisfy all data requirements becomes a complex problem. The interface problem in the ADSTAP System is further complicated by an additional factor: namely, the requirement that a capability be maintained for running subsets of the System without running the entire System. This requirement is based on the fact that users of the System are a group of individuals, each of whom may have a special interest in a particular component of the System. The subsets could take the form of an individual program, or some combination of programs. Obviously, from a practical standpoint, it would not be necessary to provide for running individual programs in all possible combinations. Thus, one of the first steps in solution of the interface problem would be to determine what subsets of the entire System would be run, and in what combinations.

At the core of this problem lies a difficult task--that of maintaining data set integrity. A data set is simply a group of like data which is either input or output of a particular program. For example, if the strength planner desired to make a run of the Strength Planning Model, it would be necessary to ensure that the Projection Model has been run with the parameters which produce data needed by the Strength Planning Model. Furthermore, as is usually the case, someone other than the strength planner may have needs which require that the Projection Model be run with certain parameters different than those established by the strength planner. In this event, it is necessary to ensure that subsequent runs of the Projection Model do not destroy the data set created by the strength planner. In addition, the strength planner himself may desire to make multiple runs of the Projection Model with different parameters in order to produce different versions of the same data set containing slightly different characteristics for input to the Strength Planning Model.

At this point, a term needs to be defined: with respect to data sets that have different versions, the individual versions will be referred to as "generations" of that data set. With this definition and the foregoing example in mind, this aspect of the interface problem can be stated as one of providing the user with the capability of having multiple generation data sets both for input and output as well as providing mechanisms for maintenance of those data sets.

In dealing with this problem, the simplest form of solution, programmatically speaking, would be to produce each generation of the data set on a medium (such as a deck of cards or a magnetic tape) so that each generation could be kept physically separate from all others. The disadvantage to this alternative is that it is primarily a manual solution. That is, the running of any component of the System is dependent upon having the appropriate physical data sets at the right place at the right time. While this may not be too difficult for a single component of the System, it becomes a very complex problem when running the entire System from beginning to end.

It seems clear then that the most desirable solution to the interface problem is one that is automated, that is, one in which the user need not physically manipulate the various input and output data sets required to run the System or a subset of the System. With this in mind, it seems helpful to think of the entire collection of all data sets necessary for operation of the ADSTAP System as a Data Base.

This Data Base, then, would contain a number of different types of data sets and each type of data set would have a number of different versions, or generations. By establishing an identification system which would uniquely identify each member of the Data Base, the user would need only to specify this identifier to refer to the particular data set of interest. Obviously mechanisms would need to be provided for removing unwanted members of the Data Base and for adding new members. In addition, the maintenance mechanisms of the Data Base would have to provide sufficient information so that the user could quickly and easily determine the status of the Data Base.

This approach is well within the programming capabilities of most third generation computer systems; however, some limitations may exist in the amount of physical space required for storage of a Data Base of this type. In any event, given currently available technology, it seems that this approach would be most rewarding.

System Interface Development and Projection Output Disseminator (PROD)

Whether viewing the interface problem as one of data set management or program management, or both, current efforts in this direction must be highly circumscribed. The reason for this is directly due to the developmental nature of the ADSTAP System. Until all major components become reasonably firm as to design and input/output requirements, little can be done in terms of designing an interface. Thus, at this stage of system development, the interface must remain a highly speculative exploratory process.

As a "stop-gap" measure designed to minimize the manual effort involved in setting up programs and communicating between modules, special output routines have been developed for many of ADSTAP's programs. In addition, a Projection Output Disseminator (PROD) has been developed to interconnect various modules of the System.

PROD is a separate computer program intended to act as an interim interface between Projection Model output and several ADSTAP System planning programs. The input for PROD is generated by the Projection Model in the form of a POLIP Tape (POLIPOUT). This tape must be specifically requested when setting up the Projection Model, and is created in binary form to reduce storage requirements. This is because POLIPOUT contains every conceivable form of output possible from the Projection Model. PROD reads the tape and, according to its control cards, aggregates the data as necessary. Card or tape output for a variable number of years is then punched or written in the form required for the Budget Cost Management Program (BUCOMP), the Strength Planning Model (SPAN), the Advancement Interface Loss Distribution Program (ADLINLSD), and the Interim Per Capita Cost Model (INPER).

The PROD program is written in FORTRAN and assumes compilation by the 'H' level compiler. As few limitations as possible have been coded into the program to avoid the need for recompilation in order to accommodate a more complex set of tasks. The implementation of this last flexibility is achieved through dynamic allocation of storage for all control tables used by the program, the sizes of which are determined at execution time via input. Appendix C, Structure of Projection Output Disseminator (PROD), contains a brief description of the operating characteristics of this program.

The following charts illustrate the current accommodation of data flows in the ADSTAP System. Figure 31 shows the subject programs, the direction of data flows, and the content of the various inputs and outputs as coded. On the succeeding page, Figure 32 contains the Interface Code which identifies variables as coded in the ADSTAP System and the form of the array or vector involved. The last chart, Figure 33, shows the operating configuration of the Prototype ADSTAP System currently implemented in the Bureau of Naval Personnel. Because of the size and complexity of the ADSTAP System, there are a large number of computer programs that are not explicitly and directly a part of the System but, nevertheless, are necessary to support the development, operation, and maintenance of the System. Some of these programs are described in Appendix D: Support Programs.

FIGURE 31

ADSTAP: System Interface

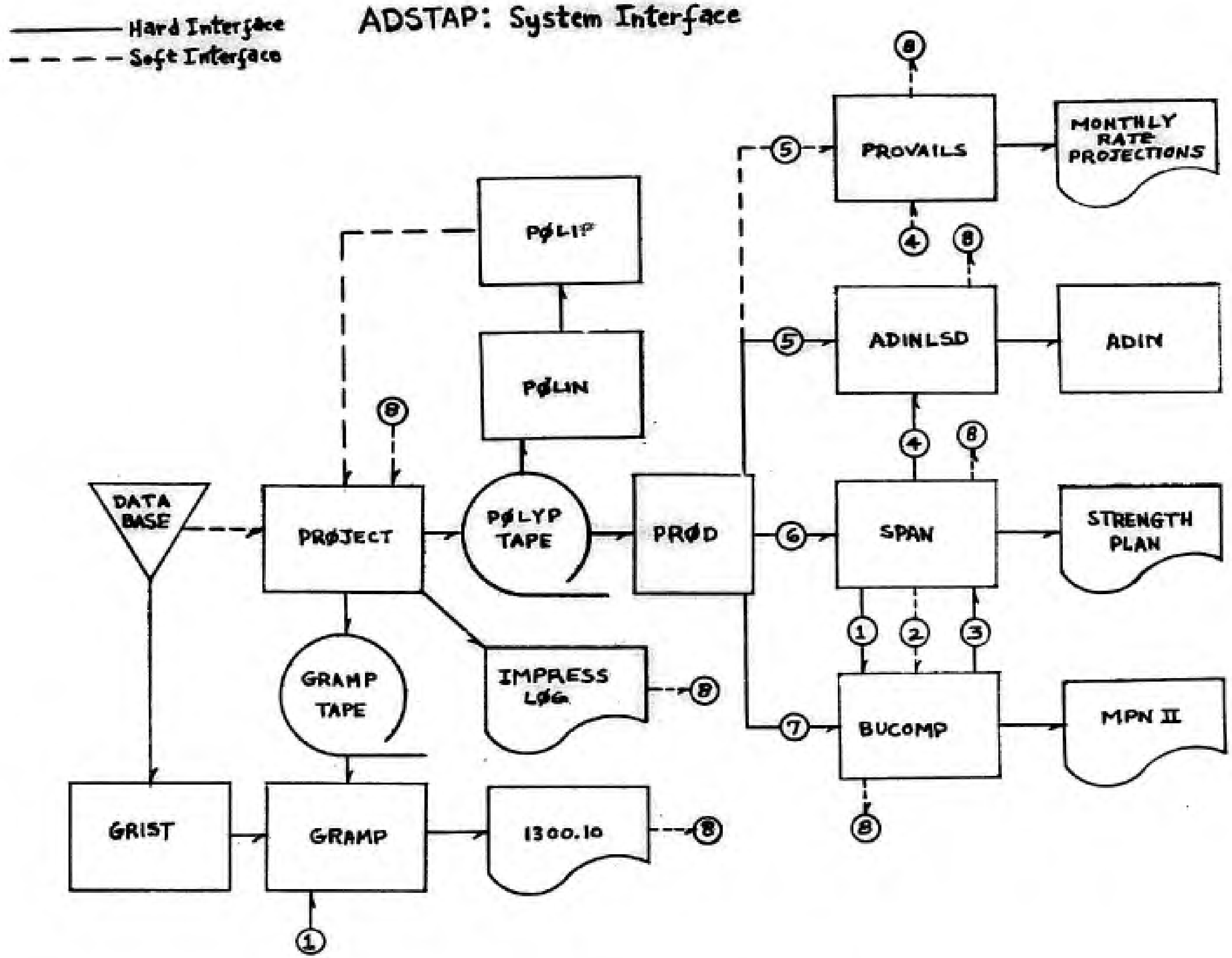


FIGURE 32. INTERFACE CODE

1 - 501(MYA): 1 x 9 ALNAV

2 - OC, REENL, etc.

3 - UNIT COSTS

4 - 999(STR), 250(LOSS), 550(GAIN), 800(ADV): 1 x 9 x 12 ALNAV

5 - 26(LOSS), 56(GAIN), 78(TP), 87(ADVIN), 88(ADVOUT), 04(STR): 1 x 9 RATING

6 - 03, 12, 15, 18, 19, 20, 33, 34, 38, 39, 40, 43, 44, 47, 48, 62, 66, 74, 77, 80, 81, 83, 84, 95: 1 x 9 ALNAV

7 - 03(STR): 9 x 31 ALNAV

04(STR): 9 x 31 RATING (AW)

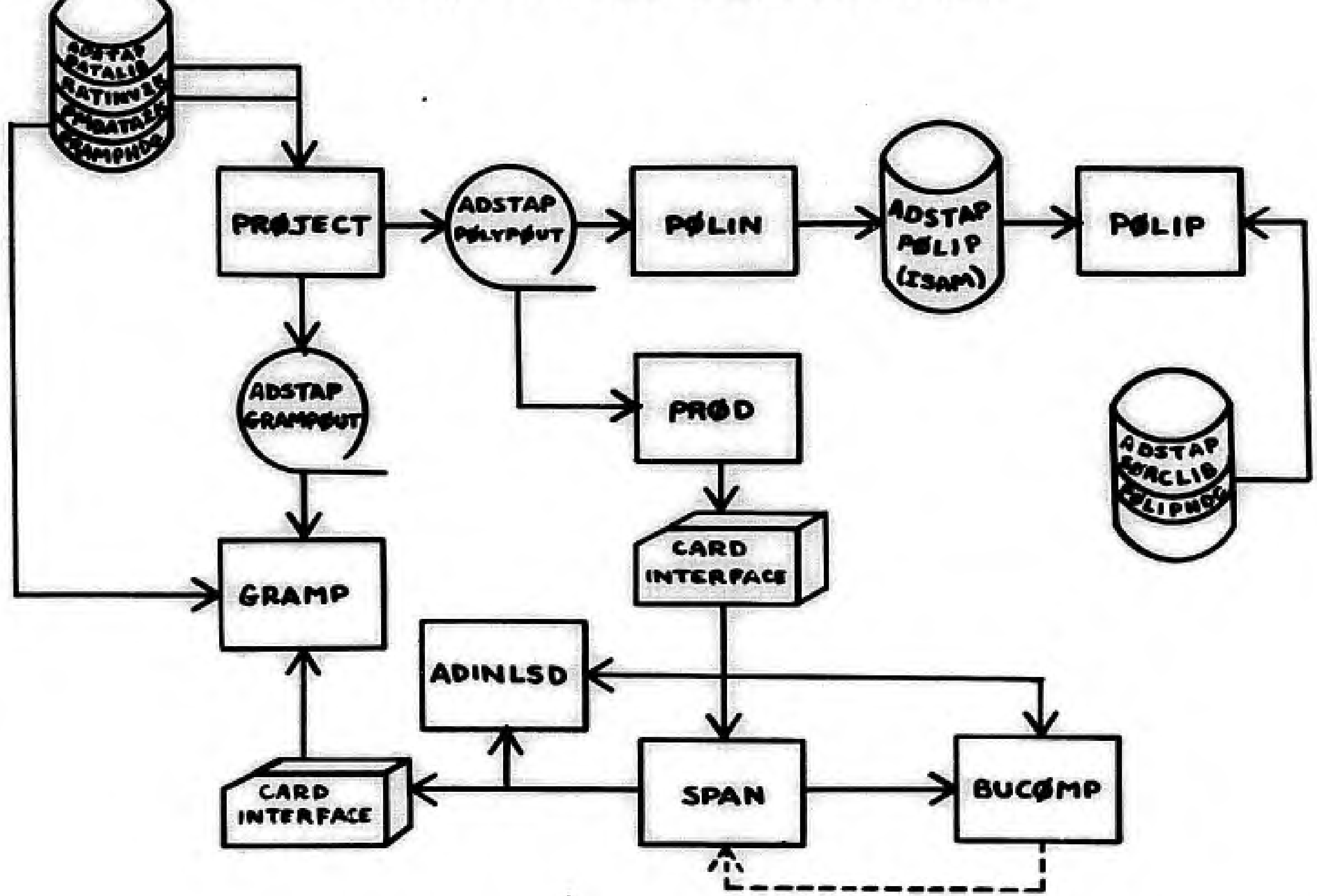
8 - POLICY SET

9 - 04(STR): 9 x 31 RATING (Net)

80(ADV): 9 x 31 RATING

10 - 60(UNIT COST): 9 x 31 RATING

FIGURE 33. ADSTAP OPERATING SYSTEM



TOWARD A HEURISTIC SYSTEM

One of the basic ideas behind the ADSTAP System is that personnel planning is a "heuristic" process. This means that decision-making in personnel management is frequently characterized by adaptive, trial-and-error procedures in which the search for a solution generates new alternatives, information, and understanding which, in turn, enable the decision-maker to narrow the search. Heuristic procedures are not suited to the solution of routine, repetitious problems or to day-to-day operations; the latter kind of process is more structured and amenable to automation, programmed decision-making, and optimization. In contrast, the relatively unstructured problems in personnel planning and policy development should be dealt with on their own complex terms--and heuristic techniques appear to hold the greatest promise in assisting decision-makers in this regard.

Structure of a Heuristic System

Figure 34 on the following page illustrates an example of a heuristic personnel management system. It consists of four major components: (1) an operational subsystem consisting of the actual personnel actions; (2) an information subsystem consisting of data necessary to make decisions concerning the management of personnel operations, (3) a decision subsystem which involves the personnel planner interacting with operations, data, and a computer simulation of the personnel system; and (4) a simulation subsystem which models the personnel system itself. More specifically, these components of a heuristic system are described below.

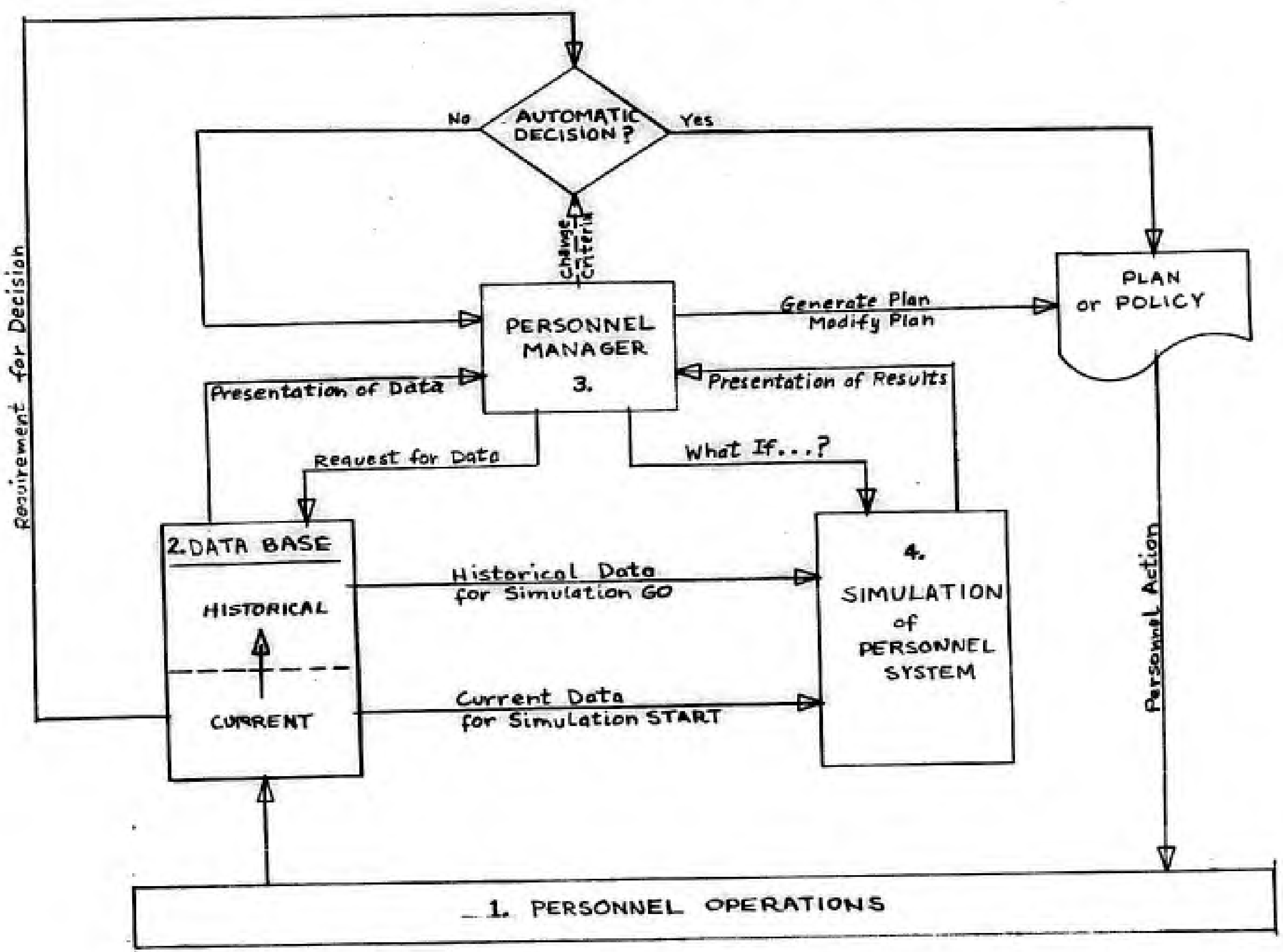
1. Personnel Operations

This component represents those functions of personnel management operations having to do with recruitment, classification, general occupational training, specific technical training, promotion, grade management, career development, loss management, retirement control, accelerated separations, service extensions, personnel cost control, distribution-assignment-detailing of personnel, rotation management, retention management, and others.

2. Data Base

This component involves the collection, storage, processing, and transmission of historical and current operating data to the decision maker. The Data Base initiates the requirement for a decision by constantly monitoring the operation of the personnel system and imparting such information to the personnel planner. On request, the Data Base generates specific information to assist the decision maker, but also is capable of developing management criteria, operating ratios, and rates of change, as well as maintaining personnel accounting records. By design, the Data Base provides information useful to the planner in defining alternative courses of action, and data on the operation of the personnel system that is useful in evaluating those courses of action. The user interacts with the information subsystem by specifying the desired level of detail, the volume, the format, and the frequency of reports. This subsystem encompasses a communications network, a set of historical files and standards, and current personnel status accounting.

FIGURE 34. A HEURISTIC PERSONNEL PLANNING SYSTEM



3. Personnel Manager

This component represents the focal point of the decision structure whereby the user directs, controls, and manages the operating personnel system based on data developed by the information system. The decision subsystem is activated by the need to fill personnel vacancies by promotion or recruitment, to provide for trained personnel, to manage strength, and to provide an arena for career progression. If the decision subsystem finds that the problem meets the existing criteria for an "automatic" decision, the appropriate decision rule is applied and the resulting personnel action is executed. Otherwise, the computer prints out the decision requirement and some relevant information, and the problem then goes to the personnel manager for further analysis. Prior to deciding, the manager may (a) call for more information; (b) elect to try out several alternatives before deciding; or (c) after the above analysis, the manager may decide to change either the criteria for "automatic" decisions or to change the current set of decision rules. The purpose of the decision subsystem is not to discover the combination of rules, ratios, or rates which will result in universally optimal personnel system performance. This is because the number, complexity, and interaction of personnel planning variables makes it extremely difficult to discover the "best" combination of decision rules. In addition, the frequency of changes in the criteria by which personnel operations are measured by managers make the concept of mathematical optimality meaningless in this problem environment. A more realistic goal is to assist personnel managers in developing personnel plans which are useful rather than "optimal." Such an approach is based on the subjective weighting of "hard" facts presented by the computer system and of "soft" facts gathered by the manager of situations external to the computer system. The manager is, of course, the final authority not only as to criteria used to make decisions, but also what kinds of decisions are even subject to computer-assisted decision-making.

4. Personnel System Simulation

This component consists of an abstracted model of the total personnel system by which the manager may test the effects of alternative programs, plans, or policies. It permits the manager to investigate various decision options in a "what would happen if" mode of operation. Thus, without experimenting on a force of 500,000 personnel, the manager may try various decision alternatives and decide which is best on the basis of the results. It is particularly important that even in the midst of the decision making process itself, the planner can step "off-line" and explore the consequences of following alternative policies in any combination.

An Example

A highly simplified example might suggest some of the flavor of a heuristic system--remembering that it is purely hypothetical.

In this example suppose that a requirement for a personnel planning decision was triggered by the Data Base. This would occur when the Data Base initiated the process by showing, for example, that last fiscal year the time in service (TIS) for all enlisted advancements to pay grade E-4 averaged 32 months. This information goes to the decision point for possible application of a decision rule. Of course, the decision rule is always subject to change both as to substance and criteria.

The decision rule states that if average TIS exceeds 36 months a plan is automatically generated to decrease the minimum TIS required for advancement to E-4 by 6 months, and if average TIS is less than 24 months, to increase the minimum by 6 months. However, in this example the average TIS was 32 months, and the decision rule states that when average TIS falls between 24 and 36 months the requirement for a decision cannot be handled automatically, but must be referred to the personnel planner or manager.

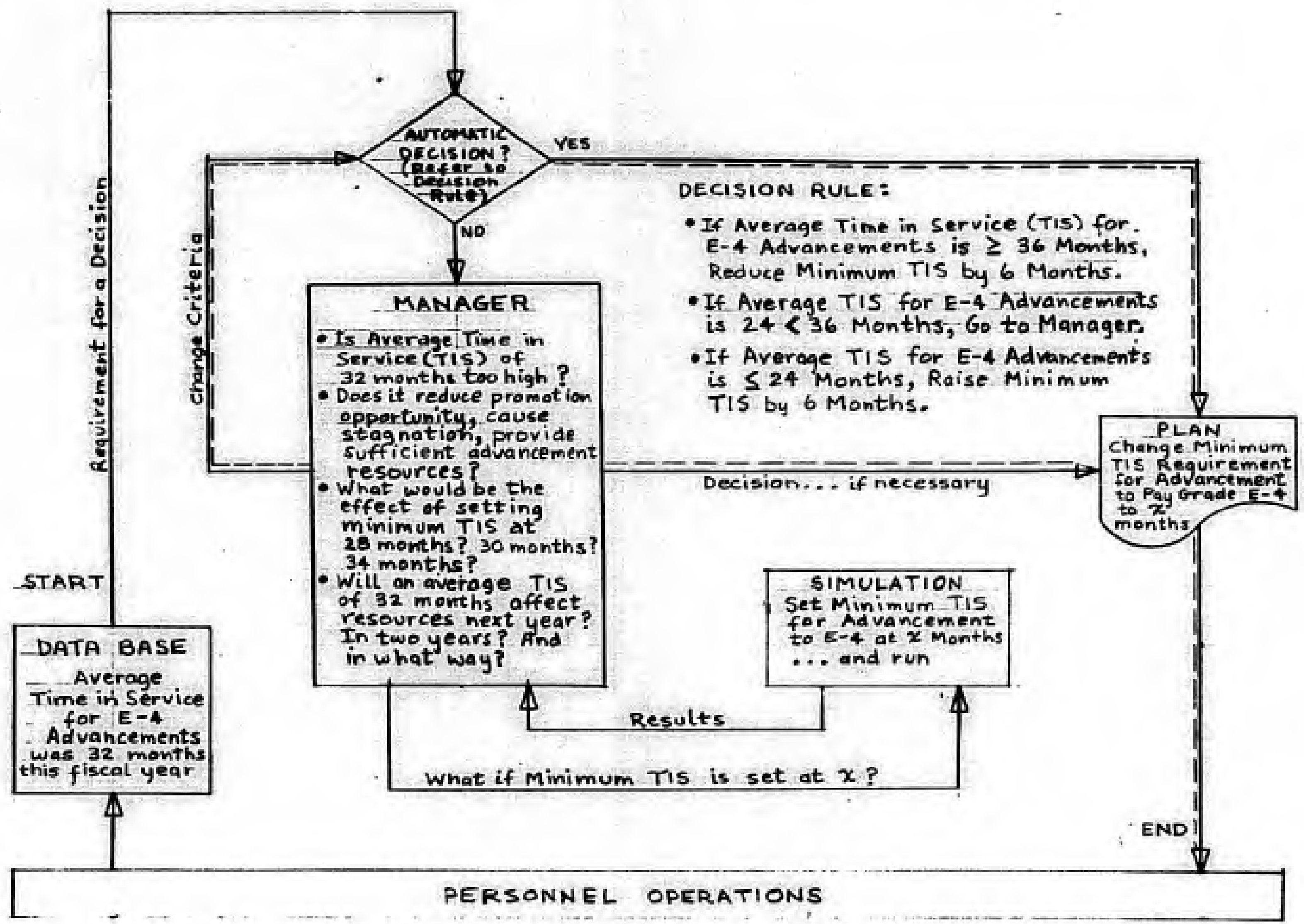
Once faced with both the requirement for a decision plus relevant information, the manager must determine whether an average TIS of 32 months is too high or too low. This leads to a whole series of questions about the impact of TIS on the entire personnel system, both currently, and in the future. Figure 35 indicates the character of some of these questions.

In order to obtain more information before making a decision, the manager queries the simulation model by asking a series of "what if..." questions. The results of such inquiry, along with managerial judgement and guidance from high authority, provide the basis for a decision on the TIS requirement. The decision may go one of three ways: (1) the manager may decide to alter the criteria employed in the decision rule or change the decision rule itself; (2) he may decide to promulgate a policy establishing a minimum time in service at some higher or lower level than current policy; or (3) he may determine that current policy is entirely adequate for present and future needs (or, alternatively, that there is no chance to change it under present conditions), and that no action is required at this time. In the example illustrated, the latter decision was made. In terms of these alternatives, it should be noted that the solid line represents the probable path through the decision-making process, given this specific example, and the dashed lines indicate alternative decision flows based on a different set of facts.

Future Development

Although the Prototype ADSTAP System has not yet achieved a heuristic mode of operation, the central concept behind the research and development effort continues in that direction. As cited in Appendix E, State of the System, such a system is still in the concept formulation stage of development. In terms of current progress and future development, Appendix E contains a coded progress report on all elements of the ADSTAP System, in which each element is shown at some stage of development from concept formulation to operational implementation.

FIGURE 35. A HYPOTHETICAL DECISION IN A HEURISTIC SYSTEM



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APPENDIXES

APPENDIX A

LOSS MANAGEMENT AND EARLY RELEASE STRATEGIES

Generally, cost reductions can be accomplished by retarding advancements and reducing or rephasing recruit input. Such actions, however, have their disadvantages. In the case of advancements, the implications for morale are obvious. If the amount of recruit input is reduced to secure a short term cost reduction, the ability of the Navy to meet its future petty officer requirements may be severely impaired. As a result, in the event of rapid drawdowns in the force level, the Navy is often forced to resort to "loss management." The latter term encompasses a number of alternative techniques, of which the most widely known is "early release" or "early out" (EO) programs. Early releases are nothing more than separations prior to the normal date of expiration of enlistment or fulfillment of active duty obligation. If the separation is three months early, the fiscal savings amount to three months' worth of pay and allowances less Permanent Change of Station (PCS) and other separation costs.

The anticipated Early Release Methodology in SPAN is designed to function in a number of different modes depending on the particular strength planning exercise. For instance, the planner can call for the early release (EO) subroutine in order to simply test the effects of various EO options unrelated to developing a specific Strength Plan. In a further refinement, SPAN would operate as an "optimization" model by determining the duration of an EO policy to achieve a specific strength or MYA objective, given the start month, operational hold or OPHOLD factor, and release unit (number of months to separate prior to EAOS). In addition, fully defined EO policies can be employed to adjust MYA or end strength as an integral part of SPAN methodology. It should be noted that only <u>one</u> EO option at a time can be employed to develop a specific Strength Plan. Thus, all EO policy testing must be accomplished prior to developing an actual Plan or the user must accept EO policies determined by the Model. In short, the planner may <u>not</u> adopt one EO policy in the base case, another in "driving" to end strength (ES), and still others in "driving" toward MYA or cost objectives. Obviously, the Navy cannot have one EO policy on top of another--much less several different ones simultaneously.

If (1) the planner is attempting to determine the "optimum" duration of an EO policy to reach a given ES or MYA, or if (2) the planner is attempting to determine the effects of a fully specified EO policy, then the appropriate mode of running SPAN would be the base case. In the event of (1), the user defines start month, OPHOLD factor, release unit, and ES/MYA objective--and SPAN would compute the duration. In the case of (2),.the user defines start month, OPHOLD factor, release unit, and duration--and SPAN would compute the losses that would result from such a policy as well as the ES and MYA resulting from the distribution of those losses.

In either of the above cases, the redistribution of losses due to a computed or specified EO policy is permanent through subsequent options. That is, in running toward ES, MYA, or cost objectives subsequent to the base case, losses may not be treated as a variable since they were set in the base case. If the planner desires to modify losses in order to reach specified ES or MYA objectives--in addition to or ignoring advancements and recruits--EO policies may not be employed in the base case. In the latter event, the base case remains as given by the Projection Model. Because only one EO policy may be established for a run series (i.e., base case, ES, MYA, cost), it is clear that only three alternatives are possible. First, an EO policy can be used in the base case, in which event losses reflect the EO policy thereafter. Second, an EO policy can be used to reach ES (however, the EO option must be exercised for a sufficient duration to move out-year losses into the year in which reduced ES is sought), but it cannot then be used to reach MYA (in which case advancements must be rephased). Third, an EO policy can be used to reach MYA (with or without advancements) only if losses were not previously modified in the base case or ES run.

In applying an EO policy, in addition to the constraints specified previously, the user would have to indicate which loss variable is to be the subject of the EO policy: (a) USN expirations of enlistment only; (b) USNR separations only; or (c) expirations and separations proportionally. The following figures show two examples of loss management strategies employing a specified set of early release parameters: Figure 36 shows a "within-year" early release to reduce man years and Figure 37 shows an "out-year" early release to reduce end strength and man years.

The first row of data in both figures shows a forecast of losses by month. Based on the starting month (October), the Release Unit (3 months), and the duration (6 months) of an early release policy, the second row shows the shift of losses that could be expected. The OPHOLD factor represents the percent of personnel eligible to be released under the policy who must be nevertheless retained because of operational considerations. In applying the OPHOLD factor (.20), the number shifted is reduced--as shown in the third row. The resulting monthly distribution of losses is shown in row four. The effect of the early release policy can be easily discerned by comparing the final distribution of losses with row one. Finally, the computations at the bottom of these figures indicates the man-month reduction expected in the case of a given "within-year" early release (Figure 36). The strength and man month reductions resulting from an "out-year" early release policy are shown at the bottom of Figure 37.

FIGURE 36. WITHIN-YEAR EARLY RELEASE TO REDUCE MAN-YEARS

Early Release Parameters:

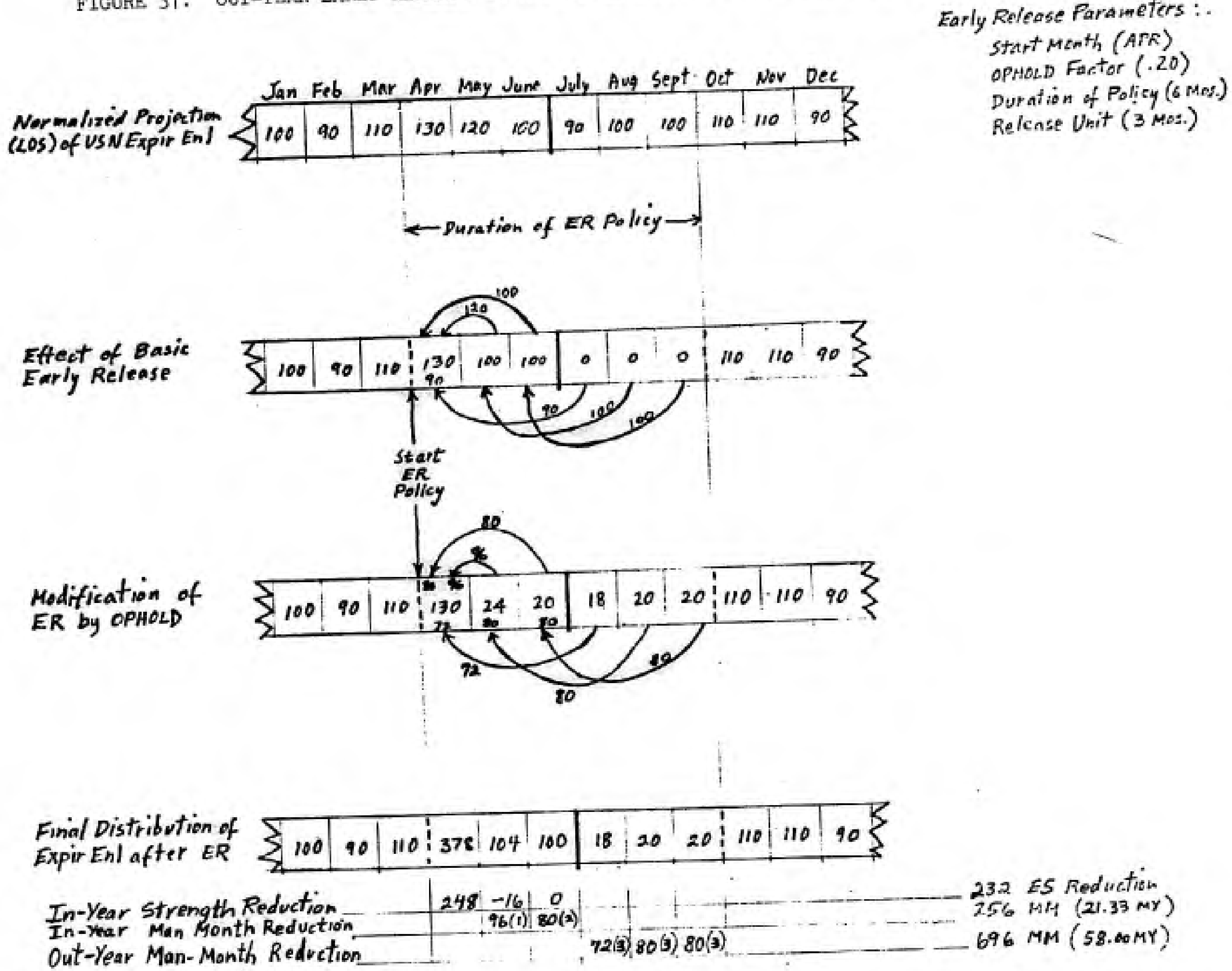
Start Month (OCT)
OPHOLD Factor (.20)
Duration of Policy (6 Mos.)
Release Unit (3 Mos.)

	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	TOTAL
Normalized Projection (by LOS) of USN Expir Enl	100	90	110	130	120	100	90	100	100	110	110	90	1250
Effect of Basic Early Release	100	90	110	100 120 130 90	100	100	0	0	0	110	110	90	1250
Modification of ER by OPHOLD	100	90	110	80 96 130 72	24 80	20 80	18	20	20	110	110	90	1250
Final Distribution of Expir Enl after ER	100	90	110	378	104	100	18	20	20	110	110	90	1250
Man-Month Reduction					96(1)	80(2)	72(3)	80(3)	80(3)				952 MM (79.33 MY)

← Duration of ER Policy →

Start ER Policy

FIGURE 37. OUT-YEAR EARLY RELEASE TO REDUCE IN-YEAR END STRENGTH & OUT-YEAR MAN-YEARS



APPENDIX B

A STEADY STATE MODEL FOR DETERMINING RATING INPUT

The following description provides a technique for determining recruit input to ratings, and hopefully clarifies some of the questions involved in solving such problems. Figure 38 illustrates the results of applying a simplified steady state model to a set of hypothetical data. This Model takes into account previous input, a "survival" function, existing resources, and future petty officer demands, and then computes the input (by rating or total Navy) necessary to meet specified force levels.

In this Model, let:

D = bottom-three end strength necessary to support rating's petty officer force;

S = existing bottom-three end strength resulting from recruit input in previous years;

I = recruit input at beginning of year (recruit input in any given year is referred to as cohort$_i$); and

r = annual rate at which bottom-three population is reduced or "decayed" due to effects of attrition and advancement to E-4 (sometimes called a "survival" function). For example, for r = .25 and I = 100, the cohort would be reduced by 25% of the original input each succeeding year; becoming 75 at the end of the first year, then 50, then 25, and finally 0 at the end of the fourth year. Similarly, an r of .10 would result in a zero cohort in ten years.

Figure 39 shows the numerical results of this "decay" process for a hypothetical rating with D = 90 and r = .25. In order to get the components of S at time T_i, it was assumed that 100 men were input each year at T_0, T_{i-1}, T_{i-2}. Each column represents the composition of that rating's bottom-three population at the end of a particular year T_i. Each row represents the remaining contribution of preceding years' recruit inputs I; the top row is the remainder of the input made at the beginning of year T_i, the second row is from T_{i-1}, and the third is from T_{i-2}. With r = .25, only three rows are required to show all population components because T_{i-3} begin-year input has gone to zero at the end of the fourth year. The next row is S, or total bottom-three population; the next row is I, or computed input for year T_i; the last row is D, or required bottom-three end strength.

FIGURE 38. A SIMPLIFIED STEADY STATE RATING INPUT MODEL

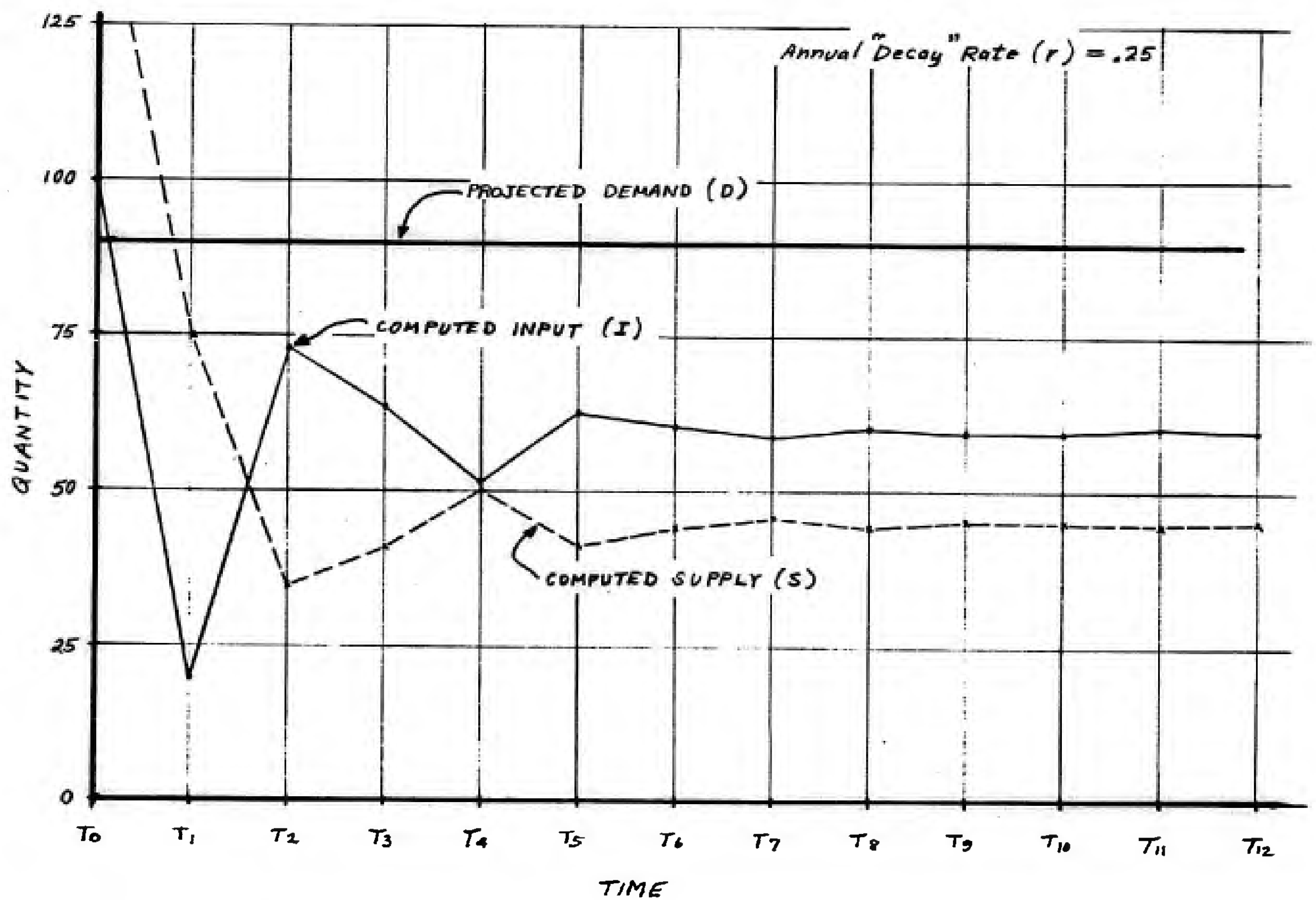


FIGURE 39. RESULTS OF STEADY STATE RATING INPUT COMPUTATION

	T_0	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9	T_{10}	T_{11}	T_{12}	T_{13}	T_{14}
End-year remainder of T_i input	75	15	55	48.3	39.5	47.5	45.2	44	45.5	44.9	44.8	45.2	44.9	44.9	45
End-year remainder of T_{i-1} input	50	50	10	36.7	32.2	26.4	31.6	30.2	29.4	30.4	30	29.8	30.2	30	30
End-year remainder of T_{i-2} input	25	25	25	5	18.3	16.1	13.2	15.8	15.1	14.7	15.2	15	14.9	15.1	15
S	150	75	35	41.7	50.5	42.5	44.8	46	44.5	45.1	45.2	44.8	45.1	45.1	45
I	100	20	73.3	64.4	52.7	63.3	60.3	58.7	60.7	59.9	59.7	60.3	59.9	59.9	60
D	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90

As can be seen in the table, the system moves toward a steady-state solution for any given set of D and r. This steady-state solution can be expressed mathematically by the following equations:

(1) $I = \dfrac{D-S}{1-r}$ where D and r are given

(2) $S = (1-r)I$

substituting (2) in (1), the following equation results:

(3) $I = \dfrac{D}{2(1-r)}$

thus, I and S may be found for any set of D and r.

Although the results in this particular example "hovers" about a steady-state solution at T_3, it really "locks in" to I = 60 at T_6 (and, of course, thereafter).

As a reminder, this Model (as well as the example) was designed to illustrate the problem and not to solve it. It is not difficult to see how the simplifying assumptions, such as fixed demand or a linear survival function, vitiate the utility of such a model for operational use. Nevertheless, it does indicate one of the possible approaches to a complex and dynamic problem.

APPENDIX C

STRUCTURE OF PROJECTION OUTPUT DISSEMINATOR (PROD)

Programmatically, PROD contains two types of control records, each in FORTRAN NAMELIST form. The first, positionally, sets array sizes and operating parameters:

&LIMS	[MAXGRP = n,]	- Maximum number of card or tape group definitions. Default value is 3.
	[LNGVEC = n,]	- Size of a vector which contains one entry for each rate-code specified for selection. Default = 500.
	[MAXYRS = n,]	- Maximum number of years for which data exist. Default = 10. LIMIT IS 10.
	[QDUMP = T]	- If specified, diagnostic information is dumped during execution and the program produces a core dump on termination. All n must be >0.
	&END	

The dynamic core requirement for a run based on the array sizes specified by the &LIMS card may be computed with the following formula:

Requirement (bytes) = [MAXGRP * (MAXYRS+1204)] + (4 * LNGVEC).

The second type of control record specifies a group of card images to be extracted; only up to MAXGRP of the following will be read.

&NL	[GRP = 'groupname',]	- Any name ≤ 8 characters. Default is 'UNNAMED.'
	[LIST = T,]	- If listing of the cards or tape is desired.
	[LIMIT = n,]	- Maximum card images for this group. (Default is 100).
	[V = list,]	- Selection criteria for 9 x 1 vectors. Default is none.
	[A = list]	- Selection criteria for 9 x 31 arrays. Default is none. (<u>And</u> 9 x 1 vector sum).
	[YEARS = n, n,...]	- Fiscal years to be output. For example, 70, 72, etc.
	&END	

'list' above refers to a series of integer items >0 separated by commas, such that any element <100 is taken to specify an item ID to be selected; if there is a series of one or more elements ≥ 100, it is taken to qualify the immediately preceding item ID selection such that the values listed are the only rate codes for which data are to be selected.

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APPENDIX D

SUPPORT PROGRAMS

The development of a system that is as comprehensive and complex as ADSTAP requires the design of a large number of different types of computer programs. In addition, the maintenance and operation of the system increases the demand for programs even more. Some of these programs are data processing applications such as extracting, formatting, "purging," and otherwise manipulating data; some are data analysis programs such as statistical applications; and some are scientific or experimental programs involved in testing new methodologies or techniques such as simulation, dynamic programming, network flow, etc.

Although many of these programming efforts have contributed directly to the development of ADSTAP, they do not always manifest themselves explicitly within the System. Such contributory efforts have been termed Support Programs, a selection of which is listed below.

1. Advancement Lag

This program calculates the relationship between advancements into E-2 and E-3 as a function of E-1 and E-2 gains, respectively, in the same month and in each of 12 previous months. These computations have been performed for each fiscal year since FY 1963.

2. Non-Rated Advancement Predictor

Using the output of (1) above, this program calculates the percent error and absolute variance of each of 25 predictors applied to 12 different lag periods in measuring the accuracy of different predictors and lags as applied to historical E-2 and E-3 advancements. The predictor/lag that minimizes error and variance is selected from this program's output and is employed in strength planning.

3. PO Advancement Variance

This program computes the difference between petty officer advancements which have been channelled through the service-wide advancement examination system and total actual advancements. The difference is assumed to represent automatic advancements. This program makes these computations for each year since FY 1965 for each rating and every pay grade, E-4 through E-9.

4. Advancement Accumulation

By accumulating advancements by rating and pay grade across fiscal year boundaries, this program is able to tally the actual number of advancements made from a particular service-wide examination. Without such a program, it would be extremely difficult to evaluate the effect of automatic advancements.

5. Term Enlistment

This program calculates the number of personnel by length or term of enlistment for advancements into pay grade E-4 of personnel in their first enlistment, and computes the percent that 6 Year Obligors are of total first term E-4 advancements. Like the program in (4) above, this program is essential to "getting a fix" on the potential number of automatic advancements.

6. Recruit/PO TIS

In order to determine the length of time it takes a recruit to be advanced to petty officer, by rating, for various years, a computer program was written to accommodate such data and calculate several parameters. It will provide the first comprehensive source of information on the flow of non-rated and striker personnel through the bottom three pay grades, as well as petty officer grades.

7. Transition

This program computes a measure of the transition of personnel, from quarter to quarter and year to year, by calculating a survival rate representing the movement of personnel from length of service i, time j, to length of service i + 1, time j + 1.

8. SPAN Distribution

There are two programs which (1) calculate the historical proportion of USN and USNR population, attrition, advancements, reenlistments, etc., and (2) calculate the monthly distribution of some 25-30 strength planning variables by pay grade. The output from these programs provides essential data used to generate Strength Plans.

9. IGBUPDT

Symbolic update program used for maintenance of programs and some card-image data files.

10. POLSCAN

Summary generator for POLIP file, used in debugging.

11. IBM-Supplied Programs

Absence would create need for writing of more programs. Dependency exists upon:

IEYFORT - FORTRAN 'G'-level compiler

IEKAA00 - FORTRAN 'H'-level compiler

FORTRAN Library, Design 'H'

IEQCBL00 - COBOL 'F'-level compiler

IKFCBL00 - IBM USA standard COBOL compiler

COBOL Library Release 18

IEUASM - ASSEMBLER, level 'F'

IEWLF880 - Linkage editor

IEBGENER - Sequential copy utility

IEHMOVE - Required for load module manipulation/transportation

IEBISAM - Required for load/unload and transportation of ISAM data sets

12. NPTRL Subroutine Library

Contains assorted elements written in various languages which must be included in link-editing of ANY FORTRAN program in the ADSTAP System for the resulting program to function properly.

There are, of course, a variety of other programs of greater or lesser complexity. In all cases, such Support Programs are a necessary adjunct to the research effort or to the ADSTAP System itself.

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APPENDIX E

STATE OF THE SYSTEM

Although the current prototype of the ADSTAP System has been developed to the point that it can be considered for limited operational use while undergoing test and evaluation, there are a number of developments planned for the future. In some cases these developments are for the purpose of improving current methodologies, and in others represent entirely new techniques and even major new components of the System. Wherever possible, these future developments have been described in various sections of this report.

Because the body of the report is organized functionally, each section contains a mixed description of completed research and development, continuing research effort, as well as future plans or research intentions. Rather than duplicate some of those descriptions in this section, a list of such items is shown below. Each item is coded according to various headings which indicate the state of research progress, namely:

A. Completed and Fully Implemented for Operational or R&D use

B. Prototype Test and Evaluation Phase

C. Computer Programming and Analysis Phase

D. Methodological and Design Phase

E. Concept Formulation Phase.

For some items, such as the Projection Model, it is difficult to indicate the level of progess. This is because the scope of the research in such cases is so broad that it covers every phase from concept formulation to final documentation. Accordingly, "mixed" areas of research are listed with multiple codes, indicating the specific phases of research.

I. Data Development Research

A. INCH - Inventory/Change Data Bank (ABD)

1. UPDATE: DO/CRT/Inventory Update System (AB)
2. CHAMP: Change Matrix Program (A)
3. DISCORE: Matrix File Maintenance Program (A)
4. RATE PGM: Rate Matrix Generator Pgm (A)
5. MOMAT: Monthly Change Matrix Pgm (D)
6. GENEX: General Purpose Extraction Program (D)
7. IMP: Inventory (EMT) Matrix Program (A)

B. EXAMDAB - Advancement Examination Data Bank (AB)

1. UPDATE: Pgm to maintain file (AB)
2. DISPLAY: Pgm to format output and list file (A)
3. TIS: Computes LOS Distribution By Exam by Rate for TT, TP, Adv. (A)
4. RATE: Computes TT, TP, Adv Rates By Exam by FY as function of source population (A)

C. CANDAB - Advancement Candidate Data Bank (CDE)

1. Extract/Format Pgms(CD)
2. Update Program (D)
3. General Purpose Retrieval Pgm (E)
4. Source Rating Pgm (D)
5. Display Pgm (E)

D. XY PLOT - General Purpose Plotting Program (A)

E. MATMAN - Computes basic operations on card input force structure Matrices (A)

F. RECORD - Computes distribution of processing lag for different changes (A)

G. SELECT - Extracts change records and searchs EMT for data comparisons (A)

II. Decision Systems Research

A. SYSI - ADSTAP System Interface or software management system (program necessary to interface components of ADSTAP System including the personnel planner) (D)

B. MANIC - Man-Machine Interface or hardware management system (programs necessary to interface computer programs, hardware support for enlisted personnel planning) (E)

C. HIP - Heuristic Personnel Planning Decision System (research to develop design parameters of a decision system embracing interaction of decision rules, data base, computer system, and personnel system simulation.) (D)

D. PROD - Projection Output Disseminator program which serves as interim ADSTAP System Interface. (A)

E. SYMAG - Research program to design and develop a management "game" for the purpose of training and evaluating enlisted personnel planners: will employ a model of the personnel system within a man-machine configured simulation of the decision environment. (E)

III. Budget Costing Research

A. BUCOMP I - Budget Cost Management Program (360/65 FORTRAN-Activ I) (A)

B. BUCOMPmod - (360/65 COBOL -Activ I-III, redesigned control cards) (C)

C. BUCOMP II - Budget Cost Management Model (360/65 COBOL-Activ I-VI including MYA-dependent variables and more extensive quantification) (DE)

D. BUDAB - Budget Cost Data Bank development (E)

1. Search and develop sources of costing data
2. Format and development pgms
3. Extraction pgms
4. Analysis pgms

IV. Advancement Planning Research

A. ADPLAN - Advancement Planning Model (A)

1. ADPLAN II - Implemented 360/65 version of Advancement Planning Model (A)
2. NETATTR - Computes net loss rates by rating and PG and formats output for use in ADPLAN II (A)

B. ADIN - Advancement Interface program; computes advancements as constrained by ADSTAP System net loss projections (C)

C. ADINLSD I - Computes 9 x 12 x 100 net losses with SPAN/PROJECT limits (AB)

D. ADINLSD II - Features option employing actuals with comparison listing (C)

E. Advancement Data Programs (A)

1. PROP - Promotion Opportunity program (computes LOS distribution of adv and its parameters) (A)
2. TERMENL - Computes term enlistment by rate by year for E-4 adv (A)
3. ADV ACCUM - Computes adv by exam year and FY, by month, by rating (A)
4. NEC/CRT ADV- Computes adv actuals vs. exam actuals by year by rate (A)

V. Policy Planning Research

A. Analysis of interrelationship of force structure parameters (E)

B. POLIP I - Policy Planning Program (initial 360/65 version) (AB)

C. POLIP Ia - Policy Planning Program with management controls (C)

D. POLIP II - Feedback model with criteria generation and POLIP/PROJECT interface (D)

E. POLIN - Program which generates POLIP ISAM file from PROJECT output (A)

F. POLHIST - Pgm which generates POLIP ISAM from INCH output (B)

VI. Strength Planning Research

A. SPAN - Strength Planning Model (latest 360/65 version) (A)

B. SPANmod - Strength Planning Model with USNR management options (BC)

C. ASP - Advanced SPAN (DE)

1. Multiple year iteration (E)
2. Options for advancement-recruit-loss trade-off (E)
3. Early out/extension methodology (D)

D. SST - Strength Planning Strategy Techniques: research to determine combinations of input-output and flow management that are "optimal" in terms of different criteria (E)

E. MODISPAC - Computes monthly distributions of historical data on strength planning variables (A)

F. NR/ADV LAG - Computes a predicted number of E-2/E-3 advancements based on lagged input at E-1 and E-2 respectively (A)

G. NR/ADV PRED - Computes FY error and sum of monthly error based on 12 different lags and 100 predictors (A)

VII. Force Projection Research

A. PROJECT - Enlisted Personnel Projection Model (latest 360/65 version)(AB)

B. PROJECTmod - Projection Model with advanced or new capabilities (BCDE)

1. Random number generator for advancement LOS distribution (B)
2. Negativity and double advancement problem (D)
3. Automatic advancement data base (B)
4. Reserve flow problem (D)
5. Design of dynamic loss methodology (E)
6. Research on MYA predictors (E)
7. Development of rates and variables (e.g., laterals; non-reenl/ non-eligibles; etc.)(D)
8. LOG suppress and ALNAV LOG (E)
9. Direct rating gains methodology (D)
10. Design of program controls (E)
11. Advancement eligible matrix methodology (D)
12. Design of TIS policy testing techniques (D)
13. Evaluation of apportionment methodology (E)
14. Research on methods of actuals input and control (E)
15. Validation research (E)

C. AEPP - Advanced Personnel Projection Model (DE)

1. Design of model management software (E)
2. Integration of LOFLOW (E)
3. Generalized branching methodology (D)
4. Development of source rating methodology (D)
5. Analysis of apportionment utility techniques (E)
6. ADIN/TRIO iteration techniques (E)
7. Output interface design (E)
8. Validation research (E)

D. GRAMP - Grade Management Program (A)

E. GRIST - Extracts, computes, formats input of historical data for GRAMP (A)

F. PROVAILS - Predicts monthly on board by rate using three different methods and lists comparable actuals. (B)

G. Force Structure Prediction Program (ACD)

1. TRANSRATE - Computes transition rates for time series of historical force structure matrices. (A)
2. TRANSPLAN - Research to develop methodology for predicting LOS configuration of enlisted structure using time series analysis (multiple programs). (CD)

VIII. Rating and Training Allocation Research

A. Research to determine pattern and stability of non-rated and striker flows in Bottom Three Pay Grades by Rating, Pay Grade, and LOS (DE)

B. LOFLOW Research - Bottom Three Simulation Flow Model development (D)

1. Inventory reconstruction techniques
2. LOS dimension
3. Gain and loss methodology
4. Bottom three advancement methodology
5. Non-rated/petty officer interface
6. TRIO and policy input design
7. Iteration methodology
8. Programming of model
9. Test and evaluation in "stand-alone" and PROJECT modes

C. TRIO - Training Input Optimization Model (D)

1. Problem formulation
2. Quantification of problem statement
3. Evaluation of theoretic model
4. Revision and restatement
5. Programming of model
6. Test and evaluation in LOFLOW/PROJECT/ADSTAP context

D. COOL - Research to design and develop C-school input planning model (E)

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SUMMARY AND CONCLUSIONS

Problem

Requirements for naval personnel, both as to number and type of skill, are undergoing continual change. This is due to a number of factors, including continuing advances and shifts in the character of technology, changing world conditions, and the volume and variety of domestic programs of a social and economic nature. In addition, oscillations in the financial resources allotted to defense and the changing composition of manpower resources available to the military services are manifested in continually changing requirements for naval officer and enlisted personnel. The dynamic nature of requirements places enormous demands on the naval personnel management system in planning the development, maintenance, and utilization of a personnel inventory compatible with manpower requirements. The focal point of this burden is the personnel manager, whatever the level or function--in short, the decision maker. The increasing criticality of this situation has intensified the Navy's effort to provide the personnel manager with advanced computer-based methods and techniques to assist in planning and controlling personnel resources in order to better meet changing qualitative and quantitative manpower requirements on a timely basis. Fundamentally, the purpose of this research is to investigate advances in computer technology and management science for possible application in the development of complex, large-scale, personnel planning decision systems.

Background

Under the direction of the Chief of Naval Personnel, this Laboratory is conducting a research program in the area of enlisted personnel planning. The thrust of this program is toward the development of computer-assisted decision systems for more effective personnel planning. Initially, however, this effort had its origins in research on striker ratios and petty officer ratios. In the course of these analyses it became apparent that the ability to achieve personnel management objectives is heavily dependent on actions taken in the area of enlisted promotions or advancements. This awareness generated an investigation of the processes underlying the advancement system, resulting in the development of new techniques for planning advancements, such as the Advancement Planning Model (ADPLAN I and II), a network flow advancement methodology, and an application of dynamic programming. As before, interrelationships in the enlisted personnel system led to research on processes of strength and budget planning which resulted in the development of a Strength Planning Model (SPAN) and a Budget Cost Management Program (BUCOMP). Because of the common need for information about future states of the system in all personnel planning, a comprehensive computer model was designed to simulate flows in the personnel system over time. This research produced a complex planning model (PROJECT) for use in making enlisted personnel force projections.

Since the development of these and other models are contingent on data in various forms and quantities it was necessary to build a large scale data bank for enlisted inventories and changes to those inventories over time (INCH), as well as special purpose data banks. It soon became clear that

research in enlisted personnel planning was evolving toward the development of an integrated, comprehensive, complex, computer-based decision system--and that such a system was capable of yielding an exponential increase in the power of decision-making techniques. More in terms of its origins than its present state, the developing system was termed ADSTAP (Advancement, Strength, and Training Plans), of which a general description is provided in this report. It should be noted that this document is not so much a report of research findings as it is a statement of progress in an area of on-going research.

Approach

Current state-of-the-art is characterized by traditional methods employing "rule of thumb," restricted applications of conventional operations research techniques, widespread use of computers for data preparation, and numerous manpower and personnel simulation and projection modelsof limited utility. Experience over the years has shown a great proliferation in model building but inadequate ties to operational capabilities. Present effort is concerned with tightening methodological and operational constraints used in the development of manpower planning tools. This requires more patient development of suitable methods of problem analysis and more cogent definitions of manpower planning problems in terms of available mathemathical model building and computerized simulation techniques. The objective of this research approach is the development of an integrated, computerized enlisted personnel planning system.

Findings, Conclusions, and Recommendations

The ADSTAP System functionally and logically integrates the objectives of enlisted strength, training, and advancement planning. In its final form, the system will enable the planning managers to accommodate rapidly to modifications in requirements, to identify significant problem areas, and to test alternative enlisted plans and policies prior to their establishment. ADSTAP will also provide the capability to forecast qualitative and quantitative personnel requirements for long-range planning purposes. This capability will be based on the adaptation of recent advances in forecasting methodology in order to provide sufficiently accurate projected distributions of military personnel inventories for detailed budget estimates, as well as for policy testing. For short-range and mid-range enlisted personnel planning, the ADSTAP System will provide the capability of evaluating and controlling progress of current policies and programs. The development of the ADSTAP System will allow personnel planners to concentrate on the problem of planning, as opposed to present time-consuming practices associated with the calculation and preparation of planning reports and documents. More important is the fact that research in the enlisted planning area has resulted in the accumulation and organization of vast amounts of data in unique forms. This permits the use of comprehensive current and historical data in the decision-making process, not previously employed with the hand-tabulation and desk calculator methods to which managers were restricted. Thus, the quality of management planning, in addition to the speed of planning, is being improved by the use of computer technology. In this sense, then, the ultimate benefit of all manpower planning models will not simply reside in lessening the workload of personnel planners, but rather in permitting the redirection of managerial effort to the most effective ends. To serve the latter objective, the ADSTAP System provides a wide range of computer models and programs which give the enlisted personnel planner a capability in decision making and policy formulation that would not otherwise be possible.