Technical Research Report 1157

AD

SUMMARY OF SIMPO-I MODEL DEVELOPMENT

Pauline T. Olson, Richard C. Sorenson,
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Elizabeth N. Abbe

STATISTICAL RESEARCH AND ANALYSIS DIVISION

BESRL

U. S. Army
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BEHAVIORAL SCIENCE RESEARCH LABORATORY

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U. S. ARMY BEHAVIORAL SCIENCE RESEARCH LABORATORY

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FOREWORD

The BESRL Work Unit, "Computerized Models for the Simulation of Policies and Operations of the Personnel Subsystem--SIMPO-I", is conducted by the Statistical Research and Analysis Division. The task constitutes the initial undertaking of an operations research requirement described in the Army Master Study Program under the title, "A Simulation Model of Personnel Operations (SIMPO)" and is Project 2Q065101M711, "Army Operations and Intelligence Analysis," under the auspices of the Army Study Advisory Committee. Subtasks include: a) Operational Analysis of Personnel Subsystem; b) Cataloging and Integration of Existing Manpower Models; c) Development of Measures of System Effectiveness; d) Development of Modeling Techniques; e) Design and Programming of SIMPO-I; f) Application and Evaluation of Computerized Models; and g) Problem Oriented Language for Management.

The present publication reports on progress in the production and planning of computerized models for use in dealing with problems related to the distribution and utilization of Army personnel and to career progression, reassignment, and rotation and for evaluating alternative personnel policies. The models developed to date are described with special reference to differences in their capabilities.

J. E. UHLANER, Director
U. S. Army Behavioral Science
Research Laboratory

SUMMARY OF SIMPO-I MODEL DEVELOPMENT

BRIEF

Requirement:

A model simulation package for assessing quantitatively the cumulative impact of personnel policy changes on the allocation, distribution, and utilization of Army personnel with special attention to effects of policies on deployability.

Research Products:

The models completed include:

DYNAMOD, consisting of four mass flow models representing varying characteristics of the Army's rotation system, while designed to deal with specific problems areas, the four models are adapted to a variety of related personnel problems.

ACCMOD, a dynamic mass flow model of the noncareer enlisted subsystem, for use in projecting accession needs.

DYROM II, a dynamic mass flow model of career (upper five) enlisted grades by which to project needed input from noncareer sources--training schools and promotion from lower grades.

Career-Noncareer Model, incorporating desirable features of the three preceding models and providing a greater number of user options.

SIMPO-I Quality Input Model. Simulation is accomplished by the flow of entities rather than by bulk flow that characterizes the above models. In this model, entities usually represent individuals rather than groups. Developed for comparison of alternative allocations of personnel for performance under varying resource conditions.

Other models in final stages of development are:

SIMPO-I GMM (General Matrix Manipulator). A related group of mass flow subroutines providing the capability of simulating many segments of the personnel subsystem. Personnel are partitioned by four measurements, at least two of which are time in state.

DISTRO. A specific application and extension of the GMM providing comprehensive coverage of the Army's personnel procurement and distribution system for estimating manpower capabilities under policy constrained deployment.

SIMPO-I GES (General Entity Simulator). An integrated package of entity subroutines providing the capability for simulating many segments of the personnel subsystem. Up to 50,000 entities and 500 nodes may be simulated at the BESRL computer installation.

Aviator Entity. A specific application of the GES designed to provide better estimates of training needs and assignment capabilities of the Army Aviator personnel system under various personnel management policies.

Utilization of Models:

DYNAMOD and the Career-Noncareer Model have been used extensively in study of the Army Aviator System. Agencies using these models have been the Capabilities and Analysis Division (CAD) and the Aviation Branch of the Directorate of Individual Training of the Office of the Deputy Chief of Staff for Personnel, the staff of the Deputy Undersecretary of the Army for Operations Research, the Executive for Army Aviation in the Office of Personnel Operations, and the Office of the Undersecretary of Defense for Systems Analysis. DYROM II and ACCMOD have been used in the regularly scheduled capabilities analysis by CAD to examine need for the Skill Development Base Program and the adequacy of projected accessions. The SIMPO-I Entry Assignment Model has been used in a study of the effects of lowering entry standards, the users being other divisions of BESRL and subsequently the Office of the Assistant Secretary of Defense for Manpower. Other models are in final stages of development and have not yet been used operationally.

SUMMARY OF SIMPO-I MODEL DEVELOPMENT

CONTENTS

Page

PART I SIMPO-I SCOPE AND PROGRESS

PURPOSE OF THE REPORT 1

SIMPO OBJECTIVES 1

MANPOWER MODELING CONCEPTS 2

USE OF MODELS TO APPRAISE THE DEPLOYABILITY PROBLEM 4

Type of Model Required 4
Suggested Model Output 5
Deployment Related Variables 6

SIMPO PRODUCTS: TOOLS FOR POLICY EVALUATION 7

PART II SIMPO-I MODELS

DYNAMOD: SIMPO-I MODEL OF THE ARMY ROTATION SYSTEM 13

ACCMOD: A SIMPO-I DYNAMIC FLOW MODEL TO PROJECT ENLISTED ACCESSION NEEDS 17

Application of ACCMOD 18

DYROM II: A SIMPO-I MODEL OF THE UPPER ENLISTED GRADES OF THE ARMY 25

Description of the Model 26

CAREER-NONCAREER MODEL OF THE ARMY SHORT TOUR-SUSTAINING BASE ROTATION SYSTEM 31

SIMPO-I ENTITY MODEL FOR DETERMINING THE QUALITATIVE IMPACT OF PERSONNEL POLICIES 38

Representative Applications 42

	Page
SIMPO-I GENERAL MATRIX MANIPULATOR	45
DISTRO: SIMPO-I APPLICATION OF GMM FOR ESTIMATING DISTRIBUTION CAPABILITY UNDER POLICY CONSTRAINED DEPLOYMENT	49
Model Concepts	49
Distribution Algorithm	55
Required Data Base	55
Rules of Movement	56
Assessment of DISTRO Coverage of Assignment Constraints	57
SIMPO-I GENERAL ENTITY SIMULATOR (GES)	58
Background	58
GES Approach	59
The GES Program System	59
Macro Design of the GES	61
Input Required	64
Output	64
Expected Applications of GES	64
AVIATOR APPLICATION OF THE GENERAL ENTITY SIMULATOR (GES)	64
LITERATURE CITED	68
DISTRIBUTION	69
DD Form 1473 (Document Control Data - R&D)	71

TABLES

Table 1.	Policies covered in SIMPO mass flow models	9
2.	Criteria used in SIMPO mass flow models for evaluating policies	10
3.	Input required for SIMPO mass flow models	11
4.	Comparison of SIMPO mass flow models as to ease of use	11

TABLES (Continued)

		Page
Table 5.	Summary sheet--DYROM II output	32
6.	Career - noncareer options	35
7.	Career-noncareer parameters which may be set by the user	36
8.	Sample summary output of the career-noncareer model	37
9.	Nondeployability for overseas assignment	57

FIGURES

Figure 1.	Diagram of flows represented in DYNAMOD	14
2.	Simplified flow model of the Army noncareer subsystem	20
3.	Tour matrices and vectors used in ACCMOD computer program	21
4.	Model of the subsystem represented in ACCMOD	22
5.	ACCMOD Flow Chart	23
6.	States and flows represented in DYROM II	27
7.	Tour vectors and matrices used in DYROM II	28
8.	Simplified flow diagram of the DYROM II	29
9.	Career-noncareer model	34
10.	Flow diagram for general computer model	40
11.	Simulation of personnel policies and procedures	41
12.	Node types in General Matrix Manipulator (GMM)	47
13.	Type 1 and Type 2 flows in the General Matrix Manipulator (GMM)	47
14.	Type 3 and Type 4 flows in the GMM	48
15.	DISTRO: Distribution-Rotation Model	51
16.	DISTRO Flows	52
17.	Basic Concept for the General Entity Simulator	60
18.	SIMPO-I General Entity Simulator: Macro System Design of entity flow mechanism	62
19.	Steps in using a simulation model	65

PART I SIMPO-I SCOPE AND PROGRESS

PURPOSE OF THE REPORT

SIMPO-I, "Computerized Models for the Simulation of Policies and Operations of the Personnel Subsystem," a U. S. Army Behavicral Science Research Laboratory work unit (manned at five scientific man-years for each of Fiscal Years 1968 and 1969), has produced a number of working models and has developed plans for others. Each model, or each family of closely related models, is documented in a report combining model description and instructions for users.

In the present overall report, the models so far produced are briefly described and the differences in their capabilities are discussed. The report is, of course, an interim publication, inasmuch as some models are still being developed. The introductory section includes a discussion of the general concepts of models and their use in policy evaluation, and points up the philosophy behind BESRL efforts. Because of the concern of the Program to Improve Management of Army Resources (PRIMAR) with policy-resultant nondeployability, special attention has been directed toward assessment of the problem and the development of rotation/assignment models with provision for representing deployability-related variables. In this connection, a special application of a simulation technique to a distribution model (DISTRO) has been developed.

SIMPO OBJECTIVES

The generalized research objectives are 1) to analyze the personnel subsystem from a problem-oriented point of view, determining points at which decisions are made and identifying operations which affect total system effectiveness and criteria by which policies may be evaluated; 2) to simulate personnel functions in the context of a personnel system in order to predict and assess the total result of policy changes; and 3) to provide a basis for an increasingly integrated approach to policy evaluation within the full scope of the total personnel subsystem. As noted above, the determination of policy changes on total personnel deployability and overall force readiness is a particularly important objective.

The potential military end result is a series of models and other procedures for assisting the management functions of the Office, Deputy Chief of Staff for Personnel. The procedures developed will be used to evaluate policies relating to the assignment, training, utilization, and contingency readiness of specialized personnel, including Army aviators. In broader terms, the SIMPO-I product will provide computer-aided operations research methods and tools that will increase the Army's in-house capability for responding to personnel management requirements.

MANPOWER MODELING CONCEPTS

In establishing optimal overall policies for distribution and utilization of personnel, many questions concerning personnel policy alternatives await objective evaluation. Problems related to career progression, reassignment, and rotation of personnel all must be considered. Experimental studies involving the real system are expensive not only in terms of cost of data collection, but also in terms of possible losses through inadequate policy or operational procedure in effect during the trial period. However, if the personnel system can be modeled and the policies applied in a computerized simulation of the system, evaluation of the policy alternatives or new procedure may be relatively inexpensive.

First, the general use of models in the study of manpower systems is considered briefly. In the present context, "model" refers to a logically connected set of rules that abstract selected characteristics of some phenomenon or system. The purpose of constructing such models is threefold: 1) to investigate dependencies among parameters, 2) to generate hypotheses concerning significant variables, and 3) to evaluate systems. Analysis of logical models often demonstrates that a policy is infeasible because certain configurations of parameters are inconsistent.

With regard to the second purpose, many of the systems modeled are complicated. The relationship between system variables cannot be intuitively determined, or may be determined only to the extent of direction of the relationship. By employing a model, it is possible to generate hypotheses regarding the extent and character of the relationship and factors entering into the relationship.

In the evaluation of systems, two sets of conditions are involved. For some models, the values of the parameters are given. These deterministic models have as a major subclass the data-free model in which the variables represent policies. The data-free models are concerned not with how the real system behaves, but with how the system would behave if prescribed policies were followed. The second set of conditions prevails when, instead of specifying the values of the parameters, the probability of occurrence of the various values for the parameters is specified. These models are referred to as stochastic models. It is sometimes considered a disadvantage of the latter model that considerable data collection may have to take place before distribution properties of stochastic variables may be estimated.

Since the systems are very complex, the models must be abstractions of the systems. Characteristics are selected so as to relate meaningfully to: 1) the givens (characteristics inherent in the system--for example, parameter values and rules which define the unchangeable characteristic behavior of the system), 2) policies which may be modified or manipulated, and 3) criteria of performance or effectiveness. In SIMPO manpower system models, the variables describing the state of the system may include the manpower requirements for specific categories of personnel at various stations, the characteristics of the personnel assets, and the already determined selection, classification, and rotation policies. The variables to be modified are the policy related variables for analysis of the effect of a particular policy change. These variables may be quite different from one analysis to another. For one analysis, the modifiable variables may be tour duration and priority for determining fill of quotas; for another, policies pertaining to permissible flow. The third type of variable, the criterion variable, is the dependent variable--the output of model computation.

A major problem in the implementation of a particular manpower model is the determination of the appropriate criterion variable. The different applications of a given manpower model may call for different criterion indexes. Even for a particular military personnel management application, one or more of the following may be among the criterion variables: reenlistment rate, selection ratio for promotion, amount of reassignment turbulence, quality of fighting force, shortages of particular types of personnel, or reduction in attrition of potential leaders. Generally speaking, criterion indexes may be grouped into two categories-restriction criteria and maximization criteria. Restriction criteria are used in identifying infeasible policies; maximization criteria are used to identify an optimal policy or set of policies.

Alternative strategies are open to the research analyst when he is dealing with multiple criteria. Policies for which some of the restrictive criterion variables do not have values exceeding the respective minimum requirements (or have less than maximum permissible values) are considered infeasible policy configurations. Special attention must be given to situations where system output is evaluated by multiple criteria. In some situations, the trade-offs among the criteria may be fruitfully investigated. Disproportionate increases in one criterion value may accompany small decreases in another. Another possibility is that of nesting optimizations.[1]

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[1] The term "nesting optimizations" refers to the establishment of a hierarchy of criterion variables in which the system is optimized with regard to the successively highest priority variable with feasible solution space reduced with each optimization. In other words, for each optimization the feasible solutions are restricted to those which do not disturb the optimization with regard to variables of higher priority.

It is of interest to analyze the significance of a discrepancy between the model criterion index and the criterion variable in the system being modeled. One contention is that the model is intended as a simulation of an ideal system. When this is the case, if the model criterion variable diverges from the system criterion index, the real system is at fault and should be modified to bring it closer to the ideal system--for example, when the variables represented in the model are manpower policies (as in some data-free models) and the discrepancy between model and real criterion indicates that the system is not operating according to officially prescribed policy. From the other point of view, the model is considered a representation or description of the actual or real system, in which case the discrepancy indicates lack of representation and is cause to modify the model and reconstruct the criterion sub-model.

USE OF MODELS TO APPRAISE THE DEPLOYABILITY PROBLEM

Under SIMPO-I, the U. S. Army Behavioral Science Research Laboratory has had responsibility for developing computer models for use in assessing the effect of alternative personnel policies on deployability.

Type of Model Required

Many assignment policies impose constraints on the ability of the Army to meet short-tour commitments. Others influence assignments to long-tour areas. In a June 1967 survey made from Preparation of Replacements for Overseas Movement (POR) reports, supplemented by information from travel orders and other sources, over 53% of the persons in the sustaining base were found not deployable to short-tour areas under assignment policies then in effect. A similar February 1968 report showed over 71% nondeployable to short tour. Of the thirteen separate categories of nondeployables shown on these reports, the five largest contained 85% of the total number of nondeployables. However, even the thirteen categories of nondeployability shown in the surveys are not sufficient to cover all the causes of individual nondeployability. Some categories contain persons nondeployable for many different reasons.

For complete flexibility of policy assessment with respect to deployability and its relationship to readiness, an entity network flow model is required. An entity model considers individuals and their associated characteristics. The individuals are moved through a network of nodes (states) according to assignment priorities and predetermined probabilities of movement, change, or loss. Some of the nodes represent duty tours; some represent temporary states or lags such as patient, leave, or student status. At each time step, complete updating of the system takes place with losses, gains, and reassignments simulated.

An entity flow model in which multiple characteristics are represented for each individual requires much more computer time than a mass flow model in which individuals are grouped by values of only two or three characteristics and in which flows occur by groups of similar individuals. File searching, sorting, and probabilistic loss routines used on a system of thousands of individuals are time-consuming as contrasted with the simply patterned movements and deterministic losses possible in the mass flow models. However, the entity model offers greater flexibility and more realism, since each individual may be considered with respect to all appropriate characteristics related to the decision being made.

When only a few aspects of nondeployability are affected by the policies under consideration, mass flow models may be appropriate for assessing the effects of policy change. At the present time, by using operational BESRL mass flow models, it is possible to assess the effect of such policies as lengthening short tours or service commitments, shortening the CONUS tour, substituting additional on-job training (OJT) for experience requirements, increasing the lag between individual training and first assignment, or changing the period of short-tour nondeployability for approaching termination of service.

It is possible to add limited additional complexity to an efficient mass flow model. However, a highly flexible mass flow model such as the General Matrix Manipulator being developed in the SIMPO project requires much more computer time than those with limited flexibility--five minutes per month as opposed to fifteen minutes for 60 months with DYNAMOD or three minutes for 60 months with the Career-Noncareer Model.

With these considerations in mind, it was concluded that the PRIMAR tools for evaluating the relationship between management policy and nondeployability should include both mass flow and entity models.

Suggested Model Output

In order to evaluate the effect of an assignment policy change, two computer simulations have to be made, the first to indicate the status of the system under current assignment conditions, and the second to indicate the system changes under a shift in policy. Output summaries list assignment policies used in the simulations and provide evaluations for each time period of interest, using appropriate criteria for evaluation of the changed policy. The criteria could be one or more of the following:

1. Possible manning levels for certain areas
2. Number deployable to the short tour
3. Total required subsystem size, or number forced out of subsystem
4. Percent of lower grade or cross MOS substitution required
5. Change in average time between short tours
6. Change in the number of men going to second short tour with insufficient time in base

Deployment Related Variables

1. Tour duration. It is management practice to limit the length of assignment in short-tour areas and to require longer interim assignment in other areas before issuing a second hardship assignment in order to maintain morale and to allow time for personnel development. However, arbitrary decisions on the ratio of short-tour and long-tour duration may require a much larger total system than necessary or anticipated.

2. Sequence of assignments. In an effort to distribute less desirable assignments equitably among members of occupational systems, men cannot be assigned directly from Korea to Vietnam or vice versa. Men with families cannot be assigned directly from Europe, Alaska, Hawaii, or Okinawa to Vietnam without delay in CONUS. Men in the lower grades are not moved directly from short tour to long tour. MAAG or Mission personnel are not sent directly to short tour when their tour is completed. The effect of such policies, even though they reflect thoughtful management practices, is to increase the number not deployable.

3. Duration of obligated service. Since inductees and enlistees may serve different terms of active duty, management might wish to determine the most effective tour length for each group. In constrained military systems, extensions may prove to be a quick source of experienced personnel; or early terminations may make room in a limited total system for additional trainee input.

4. Duration of training school. The effect of changing the length of basic and individual training on the number of persons available for assignment could be weighed against the relative efficiency of the force available. Elimination of certain courses or reduction of the number of students and instructors might change the deployability ratio.

5. Grade, skill, and experience substitution. Management may wish to evaluate the effect on deployability of changes in extent and type of substitution. Or it may wish to evaluate other deployability-related policies in terms of necessary substitution. Using nondeployability as a criterion, cross training from the MOS with surplus men to MOS with shortages might be considered. Given additional training, relatively inexperienced men might substitute for experienced men.

6. Duration of lag time between duty tours. Policies on temporary assignment between permanent assignments might also be evaluated.

7. Exemption from foreign service prior to ETS. In the interest of Army efficiency and economy, men nearing the expected end of their service are not sent to new foreign assignments. Relaxation of this policy may increase the number deployable, or cost considerations may require extension of the period of exemption.

8. Number and duration of stabilized positions. Within an assignment area, some jobs require a minimum duty tour. Changes in the number of jobs considered stabilized or in the length of stabilization could change the number deployable.

9. Other foreign service availability categories. Policies on exemption of men with certain characteristics may be changed, with resulting changes in the number of deployables.

10. Number of allowable unaccompanied assignments. Management may wish to consider the effect of allowing only one hardship tour in a specified period or during a specified term of a man's service. All system members might be required to share equally in hardship duty. Such policies would affect the number deployable.

11. Limit on repeated stabilized assignments.

12. Promotion requirements. Policy on promotion might be changed, with resulting change in the number deployable or the number in a given grade required for deployment.

13. Assignment priorities. Assignment of men according to a given sequence of priorities may lead to more nondeployables in the future than a different sequence.

SIMPO PRODUCTS: TOOLS FOR POLICY EVALUATION

The final SIMPO product is to include a series of computerized models which can be used to simulate several segments of the Army personnel system. These models are designed as tools to enable Army management to examine the effects of policy change. Because SIMPO is being developed during the time of the Vietnam crisis when the Army personnel system is subject to severe pressures from management rotation and assignment policies, it is natural that more consideration has been given to this area than to any other. Realistic simulation of the rotation/assignment system requires that policies affecting personnel transfer be explicitly represented in the simulation model or approximated in combination with other factors within the system abstraction depicted by the model.

SIMPO personnel have to date completed four mass flow models with which a limited number of assignment policies may be examined. A generalized matrix manipulator system has also been developed and a first level product tested. A specialized application of the General Matrix Manipulator has been adapted into another mass flow model which will offer extensive coverage of distribution related variables. One entity model has been developed and documented. Two additional entity models have been designed and are being programmed. The latter two entity models offer the ultimate in detailed coverage of variables planned in the SIMPO Work Unit.

The completed mass flow models have been used in examining the impact of certain policy changes on the ability of the Army to meet its commitments in the short tour. While these models are still useful, the more detailed models which are not yet (1 January 1969) completed will offer a wider choice of policies which can be considered. The newer models permit examination of distribution capabilities for other areas in addition to short tour.

Thus, SIMPO has not one model but several models to use in assessing the effects of policy change on deployability. The appropriate choice for a particular problem will depend on several factors:

The policy being considered, and how many related policy variants are to be considered.

The criterion variable--a measure of the enhancement or degradation of system performance.

The data base available.

How soon an answer is wanted.

Cost of computer time.

The policies covered in each of the mass flow rotation models are shown in Table 1. The models which have been completed and tested are DYNAMOD, ACCMOD, DYROM II, the Career-Noncareer model, and the General Matrix Manipulator. DISTRO, a specialized and extended application of methods developed in the General Matrix Manipulator, is in the final stage of development. As shown in the table, DISTRO will cover more possible policy changes than the other models. The earlier models, however, cover many policy changes which may be considered. Suppose a change in the duration of short tour is considered. Then any one of the models could be used. Or suppose a policy is being considered which would permit assignment of a man as an individual replacement within four months of his expiration of service date instead of the current six months. To evaluate such a policy, any model except DYNAMOD could be used if the system being examined fits the model in other respects. (ACCMOD depicts the noncareer enlisted system, DYROM II the career system.)

Table 2 shows the measures of system effectiveness available in the five models. Suppose the question under consideration is how many men are needed in a particular system under a given set of policies and what effect changing the duration of the rotation base tour will have on the number of men required. Any one of the models could be used if it represents the system under consideration, although under certain conditions DYNAMOD would distort system size. DYNAMOD can be used if the operations research analyst assisting the policy maker knows that the considered system fits DYNAMOD's capabilities; otherwise ACCMOD or DYROM II, the Career-Noncareer model, or DISTRO would be better.

If the criterion measure is the change in possible manning level resulting for the long tour, DYNAMOD or DISTRO should be used, since only in these models is the long tour depicted explicitly.

Table 1

POLICIES COVERED IN SIMPO MASS FLOW MODELS

Policy	Model				
	DYNAMOD	ACCMOD	DYROM II	Career-Noncareer	DISTRO
Change Duration of Short Tour	X	X	X	X	X
Change Duration of Base Tour	X	X	X	X	X
Maintain Stabilized Assignments	X				X
Maintain Long Tour	X (one version)	Partial		of same duration as CONUS	X
Early Release	X (one version)	X	Easily Possible	Easily Possible	X
Retention Related	Partial	X	X	X	X
ETS Limits on Reassignment		X	X	X	X
Granting of Pre- and Post-O/S Leave		Pre	Pre	Pre	X
Catchall Temporary Affectors	X	X	X	X	X
Catchall Permanent Affectors		X	X	X	X
Substitution of Men from Lower Grades	Partial		Partial	Partial	Possible
Limit on Use of Inexperienced Men	X			X	X
Promotion	Possible		Partial		X
Sequence of Use of Assets		X		Partial	Possible
Number of Short Tours Allowed				X	Possible
Amount of Training Output	X	X	X	X	X

Table 2

CRITERIA USED IN SIMPO MASS FLOW MODELS FOR EVALUATING POLICIES

Criteria Possible	Model				
	DYNAMOD	ACCMOD	DYROM II	Career-Noncareer	DISTRO
Manning Levels					
Short Tour	X	X	X	X	X
Sustaining Base	X	X	X	X	X
Stabilized Tour	X				X
Long Tour	one version only				X
Command Elements					X
Length of Base Tour	X	X	X	X	X
System Size Necessary		X	X	X	X
Number Early Returns to Short Tour	X	N/A	X	X	X
Turbulence		X			
Required Substitution			X		

Table 3 shows input rates required by the simulation models. SIMPO has required the model user to furnish system rates for the simulations.

In Table 4, an effort has been made to show the relative difficulty of using the five models. ACCMOD and DYROM II use a gross data base which is preprocessed in the computer according to rules agreed upon by the present model user and the model builder. The remaining three models use a starting data base for which the necessary detail has been supplied before data are input to the computer. ACCMOD, DYROM II, and the Career-Noncareer model depict two tour categories, and shortcut some of the methods used in DYNAMOD; they use less computer time and can be quickly prepared for a rerun, but they cannot be used to depict a separate long tour or stabilized CONUS tour as can DYNAMOD or DISTRO.

The present discussion has pointed out that several SIMPO models are available to assess the effects of policy change on deployability, but that choice depends on important considerations: the systems being examined, the policy being considered, the starting data available, the urgency of obtaining an answer, and the cost of computer application.

Table 3

INPUT REQUIRED FOR SIMPO MASS FLOW MODELS

Input Required	DYNAMOD	ACCMOD	DYROM II	Career-Noncareer	DISTRO
	Model				
Attrition					
For Each Subtour	X				X
For Kinds of Personnel (component, career status)		X	X	X	
Casualty					
Permanent	X	X	X	X	X
Early Transfer		X	X	X	X
Nondeployability					
Permanent		X	X	X	X
Temporary	X	X	X	X	X
Retention	X	X	X	X	X
Short Tour Usage of Training Output	X	X		X	

Table 4

COMPARISON OF SIMPO MASS FLOW MODELS AS TO EASE OF USE

Utilization Factor	DYNAMOD	ACCMOD	DYROM II	Career-Noncareer	DISTRO
	Model				
Input Required					
Summarized Inventory Available from Current Reports		X	X		
Detailed Inventory Available on Tape Records	X	X	X	X	X
Complexity of Original Input	Moderately Complex	Easy	Easy	Moderately Complex	Very Complex
Reruns (vary according to changes--for example, short tour requirements)	Moderately Complex	Very Easy	Very Easy	Easy	Moderately Complex
CDC 3300 Running Time per Sample	15min/ 60mo	1/2min	1min	3min/ 60mo	5min/ 1mo
Months in Projection	Variable	24	24	Variable	Variable

Table 1 is not a comprehensive coverage of all policies which might affect deployability. The entity models will make it possible to consider almost any deployment-inhibiting variable if a starting data base containing the variable can be supplied and if the relation of the variable to assignment practice can be fully described. Under a SIMPO contract, a general entity simulator is being prepared which will have applications including rotation, promotion, and cross-training. As a first application of the General Entity Simulator (GES), the Aviator Entity Model covering the Army Aviator System is nearing operational capability. This model will be useful in any officer rotation system and possibly for some enlisted MOS systems. With the termination of the contract early in 1969, additional specific system applications will be made by BESRL. The concept around which the GES is being designed calls for the contractor to provide a simulation mechanism, to be followed by the development of specific system models and appropriate input routines by BESRL personnel.

Another entity model which was developed to assess policies concerning the limited area of first assignments has been tested and is available for use at BESRL.

PART II SIMPO-I MODELS

DYNAMOD: SIMPO-I MODEL OF THE ARMY ROTATION SYSTEM (1)

The Dynamic Army Model (DYNAMOD) is a computer simulation package consisting of four mass flow models, each designed to represent characteristics of Army subsystems. These four models were designed to meet the user's specific needs and were employed in the study of particular problem areas. All these models have the same basic logical design and format and can be easily adapted to represent a variety of related personnel subsystems.

Each DYNAMOD model uses the technique of representing a node (state) by a vector of numbers in which the ith position represents i - 1 time periods in the state. Suppose, for example, in the vector representing officers on 1st short tour assignment, 8 have just been assigned, 6 have completed a month in short tour, 7 have been there two months, 5 three months, 8 four months, 5 five months, 4 six months, and 9 seven months. The vector representing the 1st short tour would be

8	6	7	5	8	5	4	9

Different vectors are used to represent different groups of individuals or different assignment history. In two of the DYNAMOD models, officers and warrant officers are represented separately; in all four models, different vectors are used to separate 1st, 2d, and subsequent short tours or intervening CONUS tours.

DYNAMOD models are flow models representing personnel by groups of men having similar characteristics and assignment histories as opposed to entity models which represent individuals and their characteristics separately. The flow of personnel within and between states is represented by applying loss rates to each category of personnel, advancing all men one time period, calculating the needs of each state as indicated by predesignated quotas, and then attempting to fill these needs by following a predetermined priority of fill rules. This process is repeated for the number of time periods to be projected. A diagram showing the flows and states represented may be seen in Figure 1.

In DYNAMOD, personnel lost from the system are treated as a proportion of the manpower flow through the tours per year. This flow out of the system can represent retirements, separations, and, in the case of combat tours, casualties. Losses are taken from the flow of personnel at two times: 1) when a tour of duty has been completed and the personnel are available for reassignment, and 2) when it is necessary to remove personnel from one tour of duty to fill a tour with higher priority. Loss rates must be specified by the user at the beginning of the simulation, and are applied at each updating of the system during a simulation.

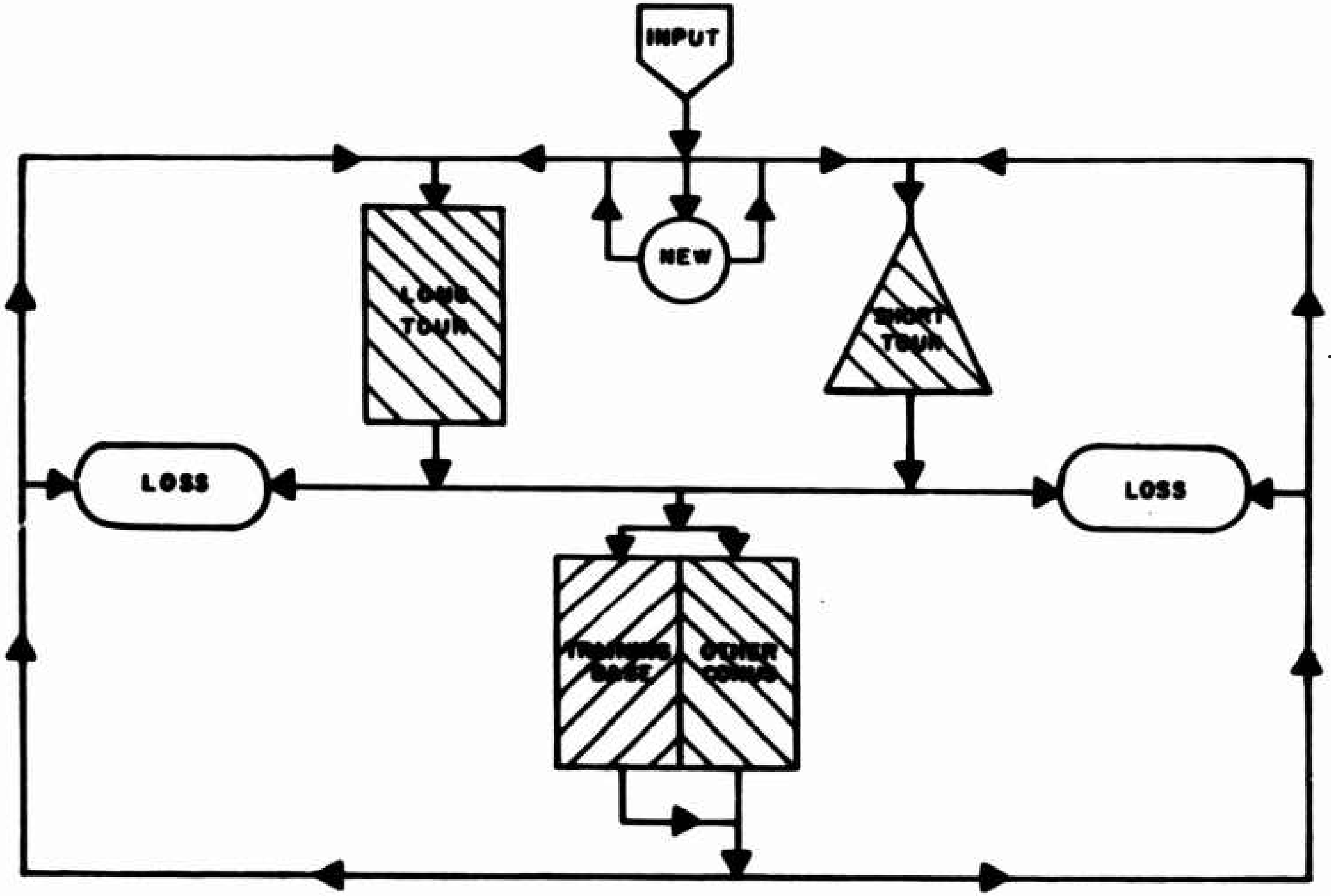

Figure 1. Diagram of flows represented in DYNAMOD

In two of the models, new loss rates may be input to the simulation at prescribed times during the computer run.

Two methods of obtaining input to the system are used in these models: 1) programmed or fixed input as specified by the user prior to the beginning of the simulation; and 2) variable input, which is calculated by an algorithm which takes into account the state of the system model at a particular time.

The priority of fill rules, or flow sequence, determines the model priority hierarchy for filling personnel requirements for the various tours and subtours. The rules specify high priority tours and the extent to which other tour requirements and flow policies are to be manipulated in order to meet the high priority tour requirements. Priority of fill rules may be specified either in hierarchical form or in terms of proportional limits; for example: Fill up to 60% of the deficit in the combat area from the rotation base. Although each of the DYNAMOD models has similar priority of fill rules, some differences were required because of policy or system differences.

In summary, in response to particular problems of interest to Army personnel system management, four dynamic flow models have been developed: Model I, the earliest DYNAMOD model, simulates the flow of personnel among four broad tour categories, one of which is a noncombat overseas tour; Model II, a widely-used flexible general model, represents the flow of two parallel personnel systems through three tour categories; Model III, a modification of Model II, examines the effects of an alternative initial direction of personnel flow within a single personnel system; and Model IV, a general model, simulates the flow of two intersecting or parallel personnel systems with separate requirements sets.

The vectors (states) provided at each tour area in DYNAMOD I are shown in Figure 2. In this model, new personnel were accumulated and held ready for assignment when needed, but no record was made of their time of entry.

DYNAMOD II has two additional state vectors for men in CONUS who have not yet been to short tour. It also combines the LONG TOUR and OTHER CONUS into SUSTAINING BASE. Other features added were provision for use of a gain or loss factor on each cell in a vector rather than only on flow between vectors, partitioning requirements into allowable experienced and inexperienced personnel, provision to substitute on-the-job training for experience if desired, options on computer output, simulation of temporary nondeployability, and the capability of changing tour lengths, loss rates, or promotion rates during the course of a simulation.

DYNAMOD III was written to examine the effects of trading early termination of service for extra time in the combat area. For this model, officers and warrant officers were not considered separately.

DYNAMOD IV features a rotation system for two intersecting personnel systems with separate requirement sets. The following tour categories are depicted:

Short Tour

Serving in A Occupation	Serving in B Occupation
1. A qualified on 1st ST	1. B qualified on 1st ST
2. A and B qualified on 1st ST	2. A and B qualified on 1st ST
3. A qualified on 1st ST	3. B qualified on subsequent ST
4. A and B qualified on subsequent ST	4. A and B qualified on subsequent ST

Training Base

Same as Short Tour except after 1st or subsequent ST

Rotation Base

1. A before ST
2. B before ST
3. A and B before ST
4. A after 1st ST
5. B after 1st ST
6. A and B after 1st ST
7. A after subsequent ST
8. B after subsequent ST
9. A and B after subsequent ST

The same features are available as before, plus the capability to simulate cross qualification training, to calculate the supplement over CONUS authorizations required to meet rotation needs and to afford rapid response to emergencies, as well as to offer additional options for computer output.

DYNAMOD was used extensively in the study of the Army Aviator System. The Career-Noncareer Model has largely replaced it because of the following limitations in DYNAMOD:

1. Service commitment could not be depicted accurately; reenlistment losses therefore could not be taken at exactly the correct time period. ETS restraint on deployment could not be represented.

2. Early return of temporary casualties could not be represented.

3. Short tour requirements had to be artifically inflated to depict temporary casualties.

4. Input data required considerable preparation.

5. Reprogramming was necessary to represent changes in flow patterns or to add additional categories of personnel.

ACCMOD: A SIMPO-I DYNAMIC FLOW MODEL TO PROJECT ENLISTED ACCESSION NEEDS (2)

The Army enlisted system may be conceptually segmented into two parts, the noncareer subsystem made up of men in their first term of service, and the career system composed of men in later terms of enlistment. ACCMOD is a model of the noncareer subsystem which corresponds roughly to the first four enlisted grades. In these grades there are two categories of personnel--inductees who serve for a total of two years with very few passing into the career subsystem, and enlistees who serve three years and have a higher probability of passing into the career Army.

The input needed to meet the requirements of the combat area while retaining in the system returnees from the combat area who have not yet completed their full period of obligated service depends to some extent on the order in which assignment of MOS personnel to the short tour is effected. If recently acquired trainees are assigned subsequent to the assignment of all available system members who have not yet served in the short tour, fewer new men need be accessioned. If available men already in the system are not assigned to short tour, the chance that they will not serve in short tour during their commitment is high relative to that for new accessions.

At the present time, Army policy does not permit individual replacement to a combat area in the last six months before a man's scheduled release date. Thus, the inductee who spends two months in basic Army training and two or three more months in MOS school has only one year during which he may be given a combat assignment. If he was not needed for immediate short tour assignment when he completed his MOS school training, he probably was assigned to an area other than combat, his availability for short tour assignment having been masked for several months while his records sifted through data processing channels. It is not feasible to reassign certain men--for example, it is scarcely practical to assign a man to a job which he must spend several weeks learning to perform efficiently, and then replace him a month or so later with another who will have to repeat the process of job familiarization. Thus, overall Army performance may be adversely affected by attempting to maximize the probability that all men will serve hardship tours. Accordingly, it is appropriate to recognize that not all men are equally deployable and to make provision for simulating that nondeployability.

In predicting the number of new soldiers required for the next two years, responsible staff agencies have had several sources of information and some computerized accounting methods to help them--more recently, earlier versions of BESRL's simulation models. However, the previous methods did not take into account the problem of maintaining high combat deployment while retaining in the system returnees from combat who have not yet finished their term of service, nor the effect of temporary nondeployability. DYNAMOD could handle both these problems with slight modification, but is not at present capable of the exact accounting of commitment duration necessary for the noncareer system. Additionally, DYNAMOD requires preparation of a fairly detailed data base which is not yet available for most MOS groups. ACCMOD uses the rather gross data base available for summaries routinely obtained from the Enlisted Master Tape Record (EMTR) and prepares the more detailed base in the computer.

Application of ACCMOD

ACCMOD data preparation follows procedures developed by members of BESRL's SIMPO Work Unit with the assistance of the Capabilities and Analysis Division, Office of the Deputy Chief of Staff for Personnel. These procedures assume a uniform distribution of men month by month within the six-month or one-year interval provided by the EMTR summaries. They provide for assignment of men to short tour at any of three stages: immediately after training and post-training leave, or one year later, or when only one year is left of their commitment.

After the input data inventory has been spread, the logic of the model is applied to system parameters and a forward projection is made. The system parameters consist of loss rates covering combat casualties in the short tour and general system attrition estimated from historical information. They include nondeployability rates which reflect: 1) the extent to which a given MOS is used within the theaters, 2) a gross estimate of assignment probability considering such factors as stabilized tours, status report lag, and other factors affecting easy availability, and 3) hardcore low utility resulting from physical incapacity, compassionate retention in base, or similar reasons. Loss rates are applied by dropping an appropriate number from the system at each iteration. Since the mean loss rate was used in developing the present model, all runs with the same data and control cards yield the same results. The outcome estimates expected results over a large number of samples and gives no indication of the range of possible results which might follow from random fluctuations in real system parameter values. But decision whether to retain or drop each man could be made on the basis of generated random numbers, in which case a range of results would be obtained and repeated application of the model would have to be made to estimate an average result.

Temporary nondeployability is simulated by using as short tour replacements only a certain percentage of the men in the assignable categories. Permanent incapacity to serve in the combat area is simulated by holding a proportion of system personnel in a category--or categories--not used for combat replacements. Actual values of the factors used are parameters supplied by the user. The portion of training base output available for short tour assignment can be specified by the program user as a rate of usage of trainees. Thus, needs of other areas for new trainees as replacements can be taken into consideration even though only two tour areas (short tour and rotation base) are specifically simulated in the model.

In obtaining short tour replacement needs, the program user also has the option of going first to training base output and then to sustaining base or proceeding in the reverse order, interchanging the two sections of Operation 24 of the computer program.

Data input has been kept comparatively simple, with two control cards per batch and four data cards per sample within the batch (group of samples which use the same control cards). Running time, including a summary printout, is about one-half minute per sample for a 24-month projection on the Control Data Corporation 3300[a]. The computer program has been coded in FORTRAN.

The Army noncareer system may be represented in the simplified flow model with links and nodes for possible flows and delays (shown in Figure 2). Delays at the nodes representing basic and MOS training and short tour are of the same duration for the two kinds of personnel considered in ACCMOD, but the stays in the various categories in the base tour depend on the duration of the individual's service commitment. The vectors and matrices shown in Figure 3 represent the states through which the inventory is distributed for simulation, with commitment and short tour duration represented by the dimensions of the vectors and matrices. Flows are limited to those possible within the separate AUS and RA subsystems, and men are kept in the subsystem for the duration of their commitment or for a lesser period, depending upon loss rates simulated. Since temporary nondeployability can be simulated by holding back a proportion of those with no previous short tour experience, a separate category need not be provided for those temporarily nondeployable.

No distinction is made between men who are permanently nondeployable at entry into the system and those who become permanently nondeployable as they near the end of their service, since men in the two groups appear to have the same effect on system performance. A slightly elaborated conceptualization of the simulated system is shown in Figure 4. Since one purpose of the simulation is to estimate the additional input needed, the computer program simulates input of additional men when they are required. The computer program also simulates input of additional men when sufficient replacements (or additions) for the short tour are not obtainable from existing deployable assets. This new input is assumed ready for immediate assignment, with training and leave already accomplished, factors which would have required induction or enlistment some months prior to the month for which the system is simulated. At the end of the twenty-four month projection, the required gross input into the MOS school is repositioned into the month during which the trainees would have entered the school.

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[a] The commercial designation of the computer is given to provide precise information concerning the model developed. Use of the trade name does not constitute indorsement by BESRL or by the Army.

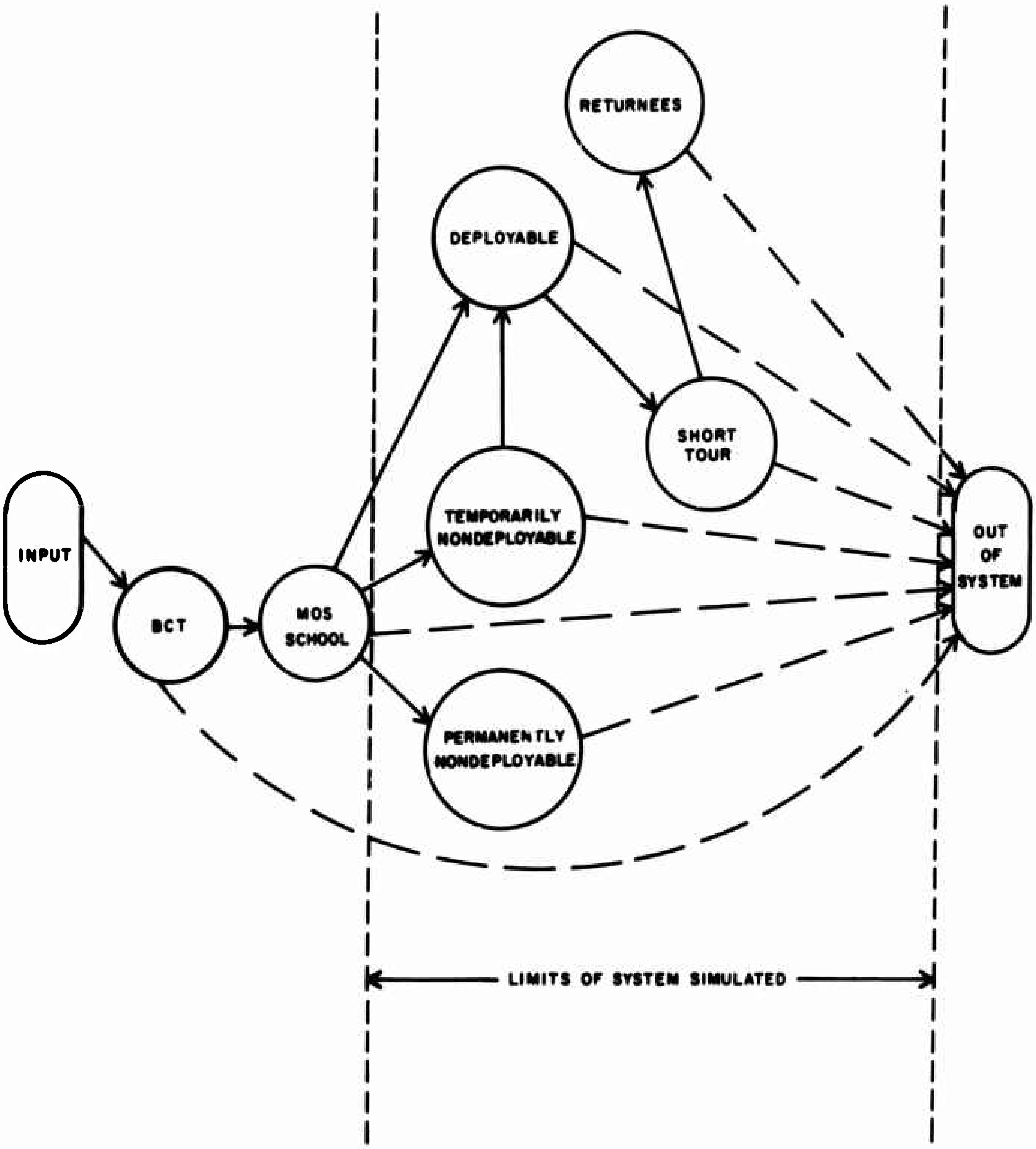


Figure 2. Simplified flow model of the Army noncareer subsystem

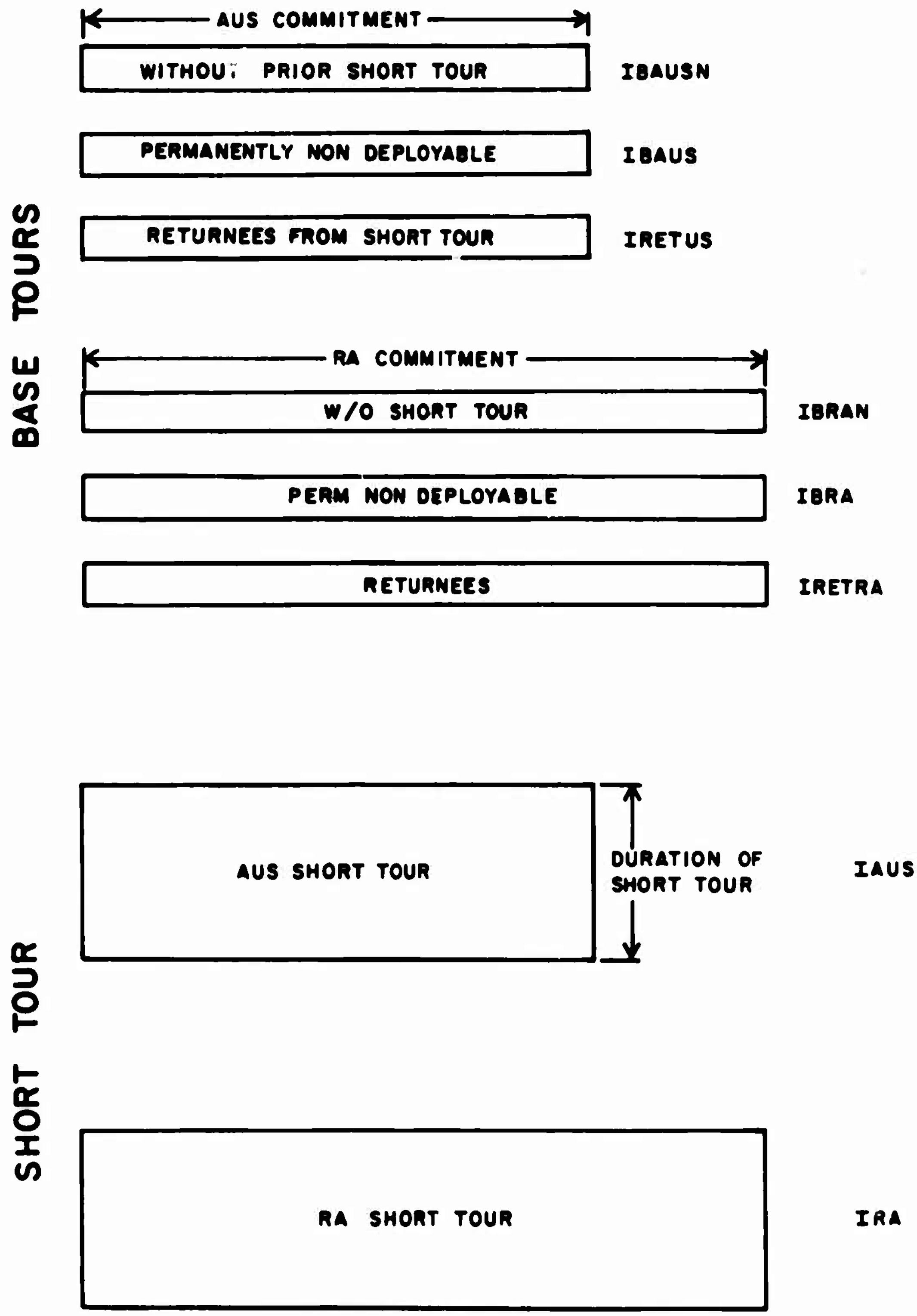


Figure 3. Tour matrices and vectors used in ACCMOD computer program

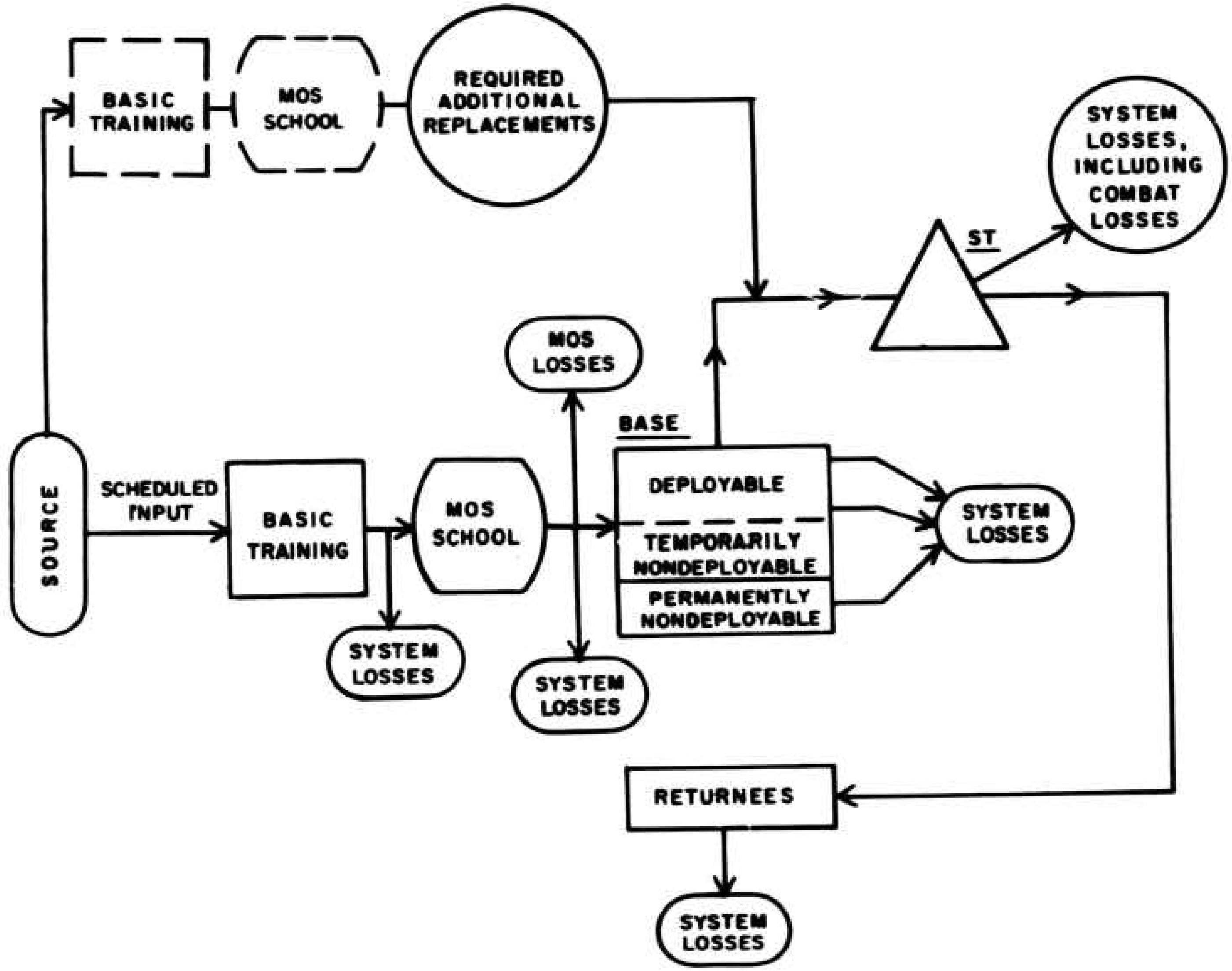


Figure 4. Model of the subsystem represented in ACCMOD

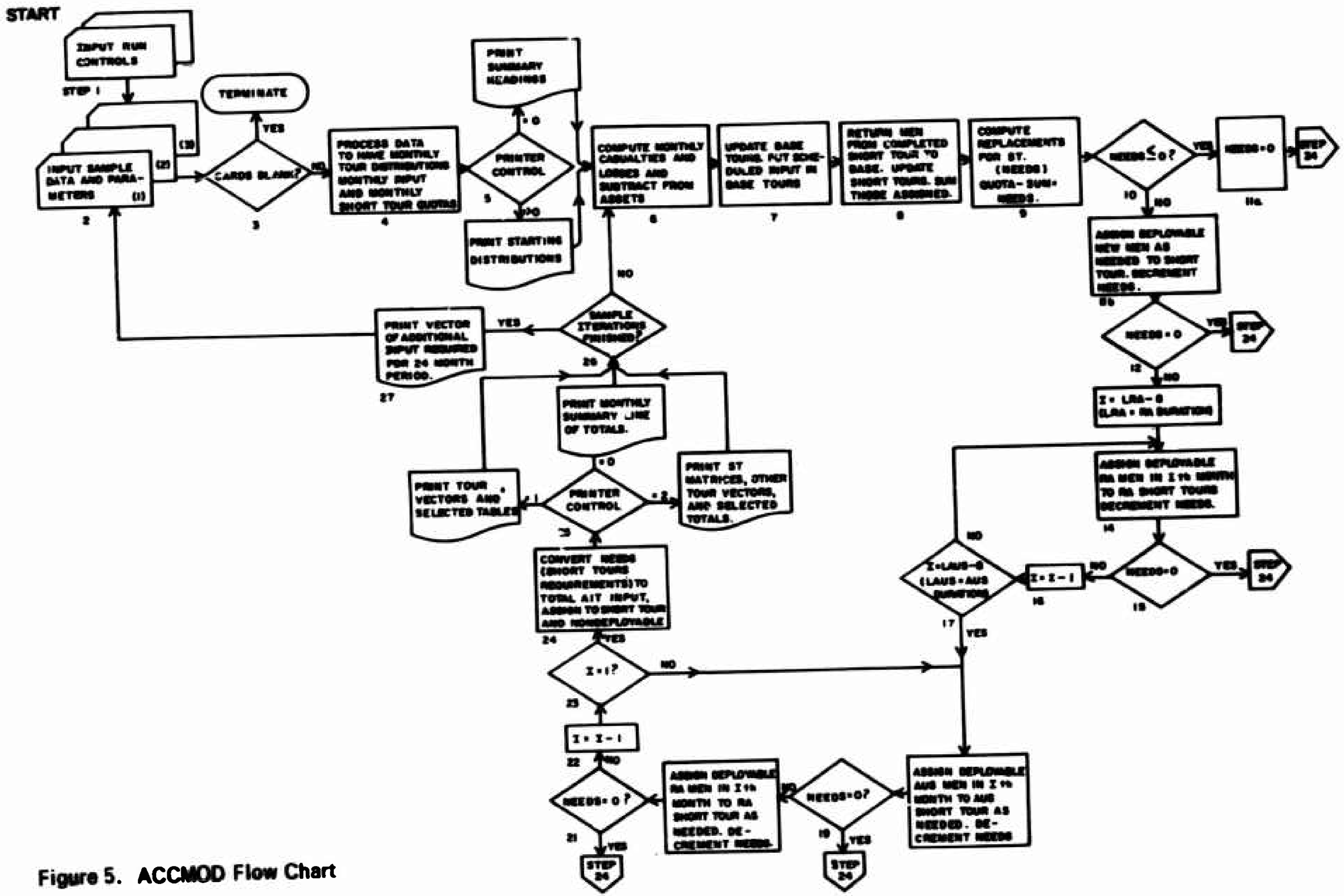


Figure 5. ACCMOD Flow Chart

Since ACCMOD represents an independent subsystem, MOS losses taken as percent of school input not graduating may not be losses to the Army as a whole. As represented here, the model makes no attempt to evaluate the overlap in losses and subsequent gains by other occupational subsystems or to examine mass substitution which might be made under the policy of mass fill. Both considerations are planned for an extension of the work started here or in connection with other models now under development in the SIMPO Task.

The sequence of simulation steps covered in the computerization of ACCMOD is shown in Figure 5, a flow chart of the program logic and decision points. About two thirds of the total program is devoted to processing and spreading the simplified data input into a form which can be updated month by month. Step 4 of the flow chart indicates that this processing has been done; the remainder of the chart is devoted to the logic of the monthly updating iteration. It is believed that future use of the model will be based upon the MOS starting inventory supplied in a different format from that now used. If this is the case, the modular structure of the program assures that the first part of the computer program can be changed to compensate for changes in the form of the data base while the remaining steps remain unchanged. ACCMOD in brief is shown in the box below.

ACCMOD FEATURES

1. Enlisted grades 1-4 within 3-digit MOS
2. Short tour sustainment
3. Temporary and permanent nondeployability factors
4. Record of time in Army and time in tour
5. Option to simulate assignment to other areas when not needed in short tour
6. Simplified data input
7. Supplemental training requirements as needed
8. Temporary and permanent casualty rates
9. Option on assignment order for new and experienced people
10. Short running time

DYROM II: A SIMPO-I MODEL OF THE UPPER ENLISTED GRADES OF THE ARMY (3)

In contrast to ACCMOD, the DYROM II, a model of the career system corresponds roughly to the upper five enlisted grades. 1968 was not an ordinary year. Rapidly expanding Army systems increased requirements for men in the higher grades. Promotions were unable to meet the full demands for new noncommissioned officers. In an effort to supply additional leaders, schools were established to take men directly from advanced individual training and train them to fill E-5 positions. Thus, what used to be the career portion of the Army is now made up of both career and noncareer men. Consequently, a simulation model which is to be used for projecting the present state of the system to some future time must represent both elements. The DYROM II provides for input to the noncareer categories from the training schools and to the career categories from ordinary promotional growth. In using the model, output from the training schools was used as it was programmed in the real MOS subsystem for the first six months of the simulation. During later months, the school output was permitted to vary as a function of the policy being evaluated. Growth to the career categories was based on projection from records maintained on the specific MOS subsystem being examined and was input to the simulation as a system parameter.

In building DYROM II, effort was made to represent the Army systems as realistically as possible in a simplified mass flow model. To fully depict the Army assignment system which must evaluate suitability of individuals for jobs on the basis of various personal attributes, skill qualifications, and past service experience, and integrate the individuals so categorized with overall system requirements and management considerations, a complicated entity flow model would be required. However, mass flow rotation-assignment models such as DYROM II can do a better job than a simple head count-job count distribution method, especially since two assignment constraining variables are represented specifically--time in system for noncareer men and time in rotation base after short tour assignment for both career and noncareer men. In an effort to account for other assignment inhibiting policies, DYROM II uses two nondeployability factors. One, for permanently nondeployables, sets aside part of the personnel assets as permanently not assignable to short tour areas. Individuals in the permanently nondeployable category spend the entire simulation period in the rotation base tour. The other, for temporary nondeployables, retains in the base tour a percentage of the men in each category of the rotation base normally searched for assignable assets. Proportions of men held back were based on a report from the enlisted master tape record (EMTR) for the particular MOS subsystem being projected.

DYROM II uses a simple summarized data base--two punched cards of batch control information and four cards of subsystem information. It requires about one minute of Control Data 3300[3] computer time for a

[3] See footnote 2 on page 19.

24-month projection, including time for an on-line printer to output detailed summary vectors for the capabilities analyst and a ledger-sheet summary for management. Thus, reevaluations of systems are possible without difficult data preparation or excessive use of expensive computer time.

Description of the Model

The portion of the Army personnel system represented in DYROM II is shown in the network flow diagram in Figure 6. Flows from the career nodes to the loss sink are not represented in the model, since the concept of net growth covers the combined effects of losses and gains.

Within the computer program, the tour nodes are either vectors or matrices, depending upon the career status of the personnel represented (see Figure 7). Since only one short tour assignment was expected to be given to noncareer men, no accounting for time in base tour was made for noncareer men who returned from the short tour. Months the career man remained in rotation base were counted through a specified duration (25 months, according to present policy). The men then went into an "assignable" category.

Two casualty rates were applied to the short tour, one for permanent casualties to the Army and the other for temporary casualties (those returned to the base from short tour before expiration of their expected tour). The actual rates used were a function of the number of casualties forecast for the MOS and the number in short tour. Data were furnished by the user. Temporary casualties were returned to the base tour for returnees and were not considered for a second short tour.

A simplified flow diagram of the DYROM II is shown in Figure 8. The data input for each group of samples included the duration of short tour and rotation base, total expected number of patients and casualties, and rates of permanent nondeployability and permanent casualties. For each individual sample, the basic inventory of assets, to include number in short tour, total number, and number of returnees with less than 24 months since a short tour assignment, was input. The returnees were grouped in six-month blocks. Short tour requirements and TOE/TD authorizations were also input. Rates were input for each sample for temporary nondeployability, casualties, retention, proportion of draftees as opposed to enlistees, and transients-patients-students (TPS). The duration of the MOS skill development course, estimated number of extensions, estimated growth (in six-month blocks), and scheduled training output for the first six months were supplied.

The number of casualties for the individual sample was calculated by using the total casualty estimate multiplied by the sample rate. The six-month growth totals were changed to monthly increments. Short-tour requirements quotas were set by linearly advancing from the short tour inventory to the first six-months requirement, then to the second, and so on. (Option was provided to set the quota for the first six months

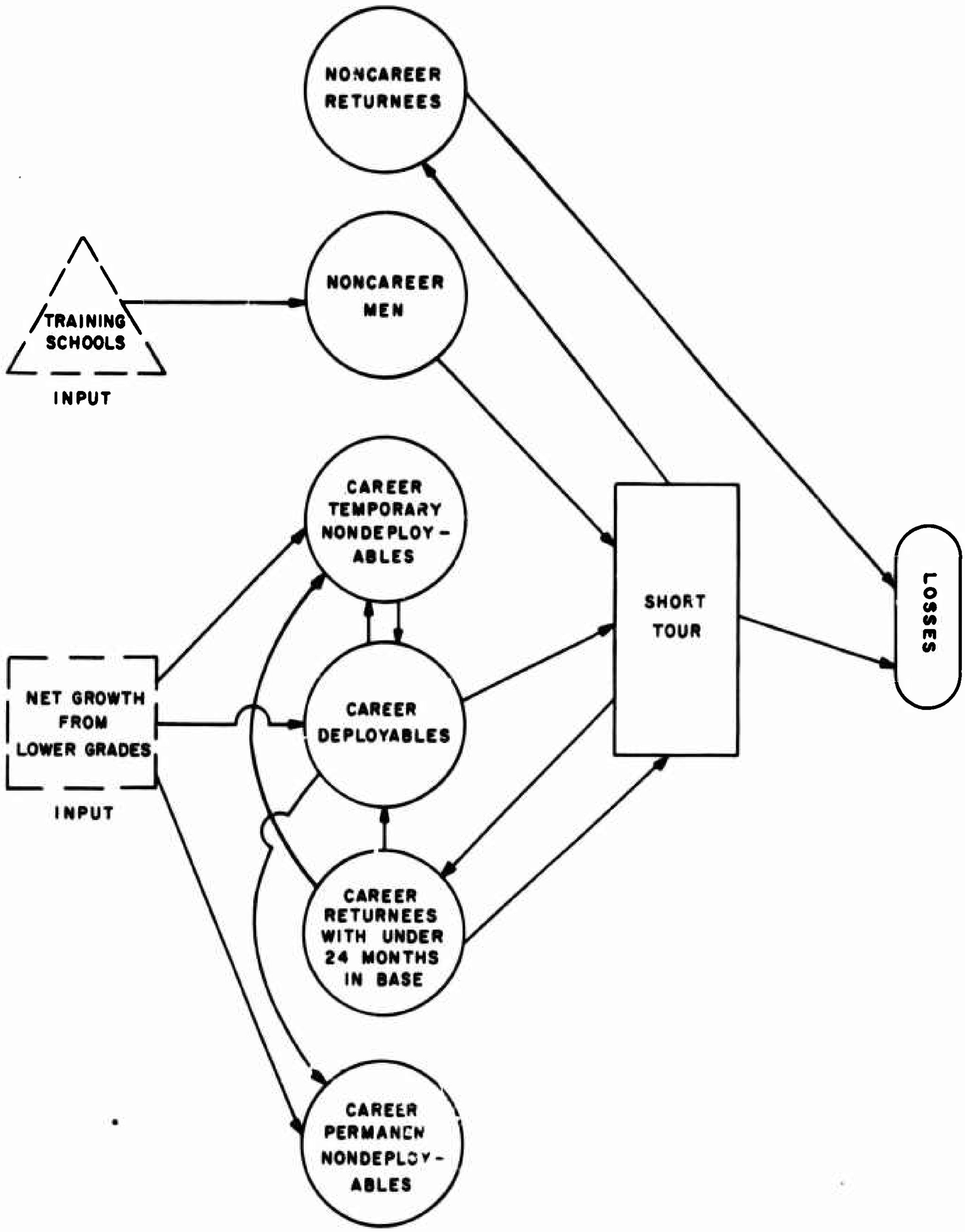


Figure 6. States and flows represented in DYROM II

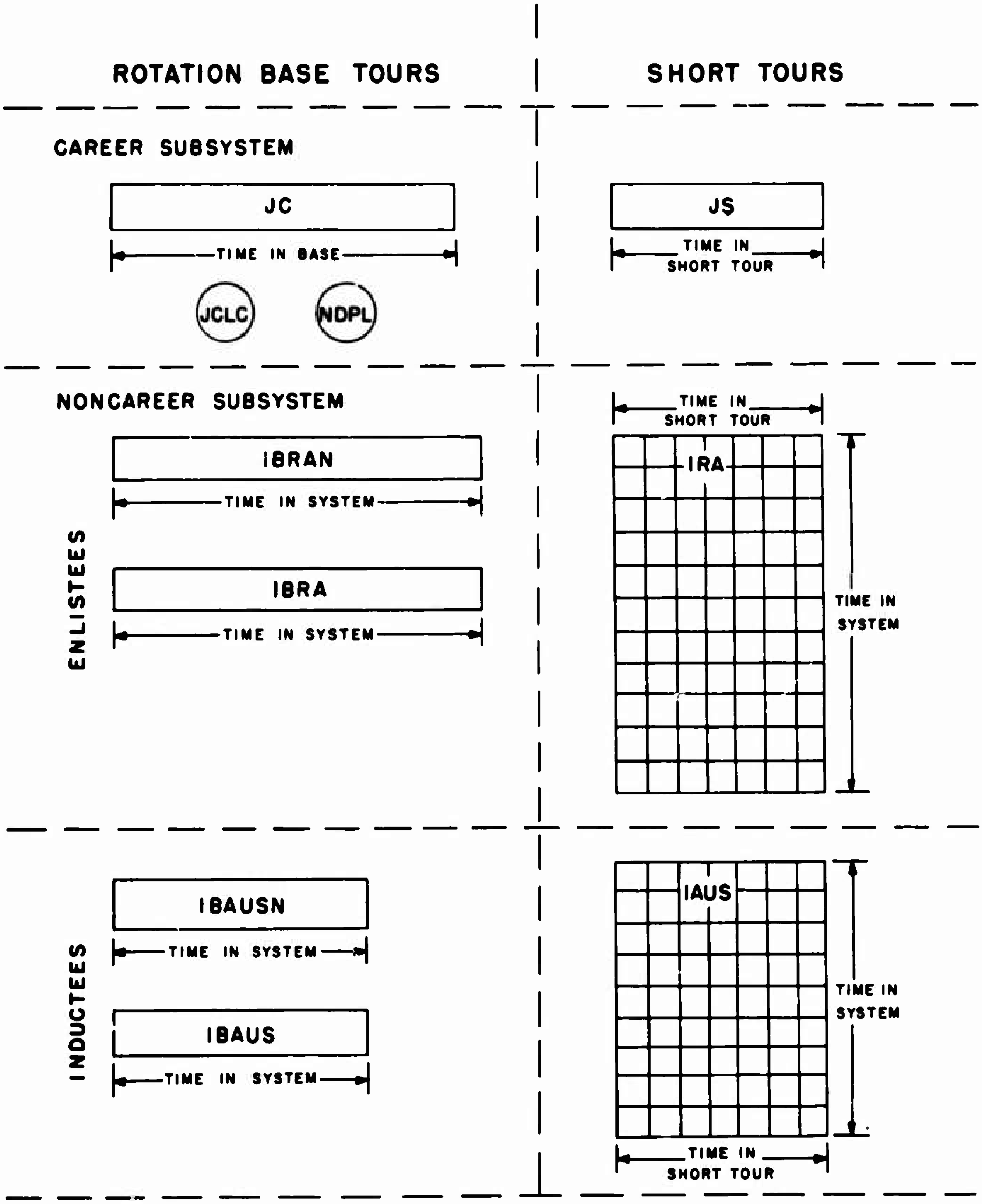


Figure 7. Tour vectors and matrices used in DYROM II

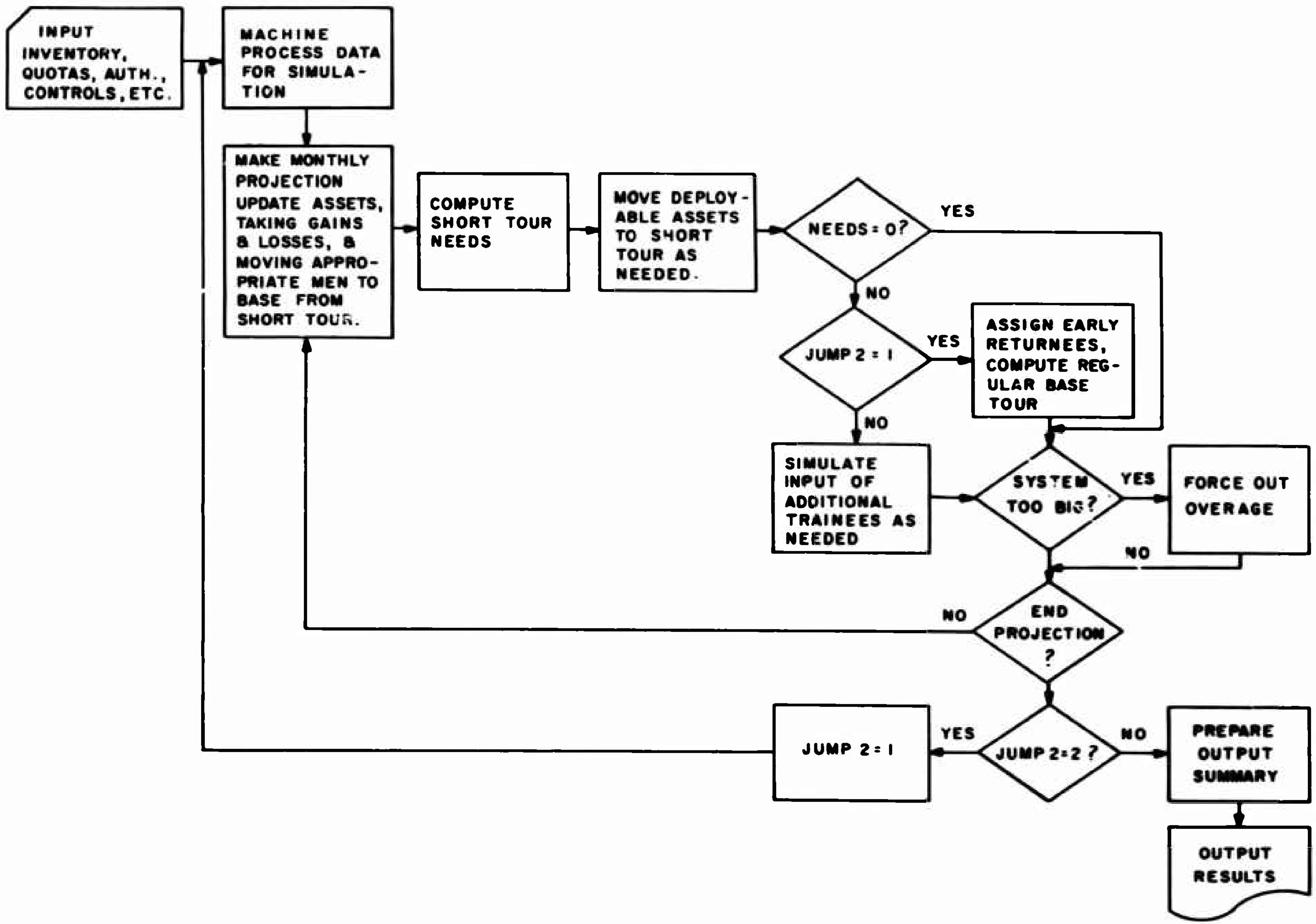


Figure 8. Simplified flow diagram of the DYROM II

lower than the full value, if desired). The short tour quotas were incremented by patients in theater, and total authorizations were increased by the TPS factor. The total number in short tour was spread into equal monthly portions in the career short tour vector. The six-month blocks of returnees were spread into equal monthly parts in the career sustaining base vector. The total inventory was multiplied by the permanent nondeployability factor, and these assets were set aside. The remainder of the assets (total minus short tour minus returnees minus nondeployables) was put in the assignable category. At the start of the simulation, it was assumed that all assets belonged to the career system. Monthly updating consisted of taking casualty losses from short tour and adding to the assignable category net growth and the number completing the specified base tour. Net growth was modified in keeping with the permanent nondeployability factor. The returnee vector was updated. Those in the last position of the short-tour vector were moved to the base tour, and the short-tour vector was stepped up one month. Replacements for short tour were then computed. The number with completed base tour was multiplied by one minus the temporary nondeployability factor, and these assets were assigned to short tour as needed. If more men were needed, two alternatives were available: 1) Additional trained assets could be input. These would be displayed in results as additional requirements for training output at this particular month. 2) Returnees with less than the specified tour in base would be returned to short tour, and their average base tour would be output in results. The model provided for limiting training output to that scheduled for the first six months simulated. New input was split between enlistees and inductees as indicated by a rate read as a parameter for the sample. The two alternative simulations were accomplished under control of a model option which caused the model to do either or both simulations.

New system and tour totals were then calculated, and a check was made to see if the system was within authorized strength. If not, a force-out of the overage was simulated with noncareer returnees forced out first and then career returnees, if required. Totals were then corrected. This updating step was repeated each month for twenty-four months.

At the end of the simulation, monthly values were combined into six-month blocks to give appropriate information for the management-oriented summary sheet, a sample of which is shown in Table 5. DYROM II features are shown in the following box.

DYROM II FEATURES

1. Used for enlisted grades 5-9, officers or warrant officers in 3-digit MOS
2. Short tour sustainment
3. Covers temporary and permanent nondeployability factors
4. Provides record of time in system and time in tour
5. Use of net growth concept to depict promotion from lower grades
6. Simplified data input
7. Option to simulate system with or without additional trainees
8. Temporary and permanent casualty rates
9. Variable CONUS tour, restrictions on assignment close to end of 1st commitment
10. Management oriented model output

CAREER-NONCAREER MODEL OF THE ARMY SHORT TOUR-SUSTAINING BASE ROTATION SYSTEM

In modeling the Army assignment-reassignment process during Fiscal Years 1968-1969, the SIMPO effort has been influenced by the urgency of the problems confronting Army management. Because short-tour sustainment has been an overriding concern, some of the rotation models developed in SIMPO have represented only two tour areas, with subcategories within these tours to correspond to types of personnel represented or previous system experience, or both. Both ACCMOD and DYROM II fall into this class of model, as do also the Career-Noncareer Models here under consideration. ACCMOD and DYROM II, completed earlier, were developed to represent separately the lower enlisted grades (noncareer) and the upper enlisted grades (career). DYROM II may also be used in projecting officer MOS groups. Because the separation of these two parts of the Army MOS system is an artificial one, a model which may be used in projecting all parts of an MOS system (at the 3-digit level) simultaneously is more realistic. The earliest mass flow model, DYNAMOD, used this approach. However, because DYNAMOD did not monitor time in the Army, the heavy loss of inductees at the end of two years' service could not be realistically depicted, nor could a constraint on assignment for those soon to be discharged be represented. Thus, the enlisted MOS could not be validly projected. The Career-Noncareer Model was designed to overcome these deficiencies.

Since the desirable features of all three earlier models were incorporated in the Career-Noncareer Models, many user options are available. However, because only two tours are represented, the model takes very little computer time and requires little data preparation to obtain reruns when a policy change is being considered.

Table 5

SUMMARY SHEET--DYROM II OUTPUT

Sample Code	31Dec67		30Jun68		31Dec68		30Jun69		31Dec69	
1.	31Dec67		30Jun68		31Dec68		30Jun69		31Dec69	
2. **Requirements**										
3. Short Tour	2658		3361		3367		3367		3367	
4. Base Structure	3857		3997		4006		4006		4006	
5. IRS in Base	955		1080		1082		1082		1082	
6. Total	7470		8438		8455		8455		8455	
7.		Jan-Jun		Jul-Dec		Jan-Jun		Jul-Dec		
8. **Deployment**		68		68		69		69		
9. Rotation Replacements		837		920		2124		1227		
0. Other Replacements		974		292		0		0		
1. Casualty Replacements		54		25		26		21		
2. New Deployment		703		6		0		0		
3. Less - Extensions		-90		-90		-90		-90		
4. Total		2448		1153		2060		1158		
5.										
6. **Assets**										
7. Actual Assets			6329		6723		7091		8456	
8. New Growth			105		105		105		105	
9. Student Output			300		0		0		0	
0. Less - Student ETS			-0		-0		-83		-0	
1. Less - Casualty Losses			-11		-11		-12		-6	
2. Total	6398		6723		6817		7101		8555	
3. **Nondeployables**										
4. In Short Tour	1684		3069		3093		1982		2977	
5. Returnees Less Than 24 Months	2195		2640		2917		4149		4294	
6. Non-structural Personnel Rev.			1013		806		939		794	
7. Total			6722		6816		7070		8065	
8. **Deficit**			-0		-274		-1385		-390	
9.										
0. **Returnees Forced Out of MOS**			0		0		30		489	
1.										
2. **Alternatives**										
3. A. NCO School Output			0		274		1385		390	
4. Trainors										
5. Students										
6. B. Grade Substitution	974	(36.7)	292	(8.7)	274	(8.2)	1659	(49.3)	1775	(52.8)
7. C. Returnees Less Than 24 Months			300		250		2142		726	
8. Avg. Base Tour of Returnees			23		24		17		12	

The tour categories depicted in the most complicated of these models are shown in Figure 9. The noncareer tours are depicted in matrix form with one dimension representing time in tour and the other time in the Army. The career tours are vectors which represent time in tour by position in the vector. Separate vectors are provided according to the number of short tours personnel have served.

User options available in these models are shown in Table 6. Parameters used by the model are shown in Table 7. A sample output table is shown in Table 8. Column headings have the following meanings:

Number	Heading	Explanation
	Month	Time period simulated
1	ST Quota	Requirements for short tour
2	End Tour	Number completing assignment in short tour
3	Perm Cas	Short tour casualties to the Army
4	ST Cas	Number returning to base from short tour before completing the tour
5	Repl Req	Number needed to bring short tour up to requirements
6	Repl Sent	Number found by model to send to short tour
7	New Repl	Inexperienced men sent to short tour
8	Ret - 25	Men sent to a short tour with less than 25 months in base
9	2d Tour	Number of men being returned for second short tour
10	3d + Tour	Number of men being returned for third or subsequent short tour
11	Avg Bs Tr	Average time in base for men in Column 8
12	ST on Hand	Number actually assigned to short tour
13	N Base - 25	Number in base with less than 25 months since returning from short tour
14	Retnt Addns	Number passing from noncareer system to career system
15	Car Tot	Total number in career system
16	Inpt Schd	Training output programmed
17	Addl Inpt	Computer generated training needed to minimize returnees while maintaining experience requirements
18	Attrt Loss	Losses from system by resignation or promotion
19	ETS	Losses from failure to extend commitment
20	Syst Tot	Total number in system

Parameters and rates are printed on the page preceding each run summary.

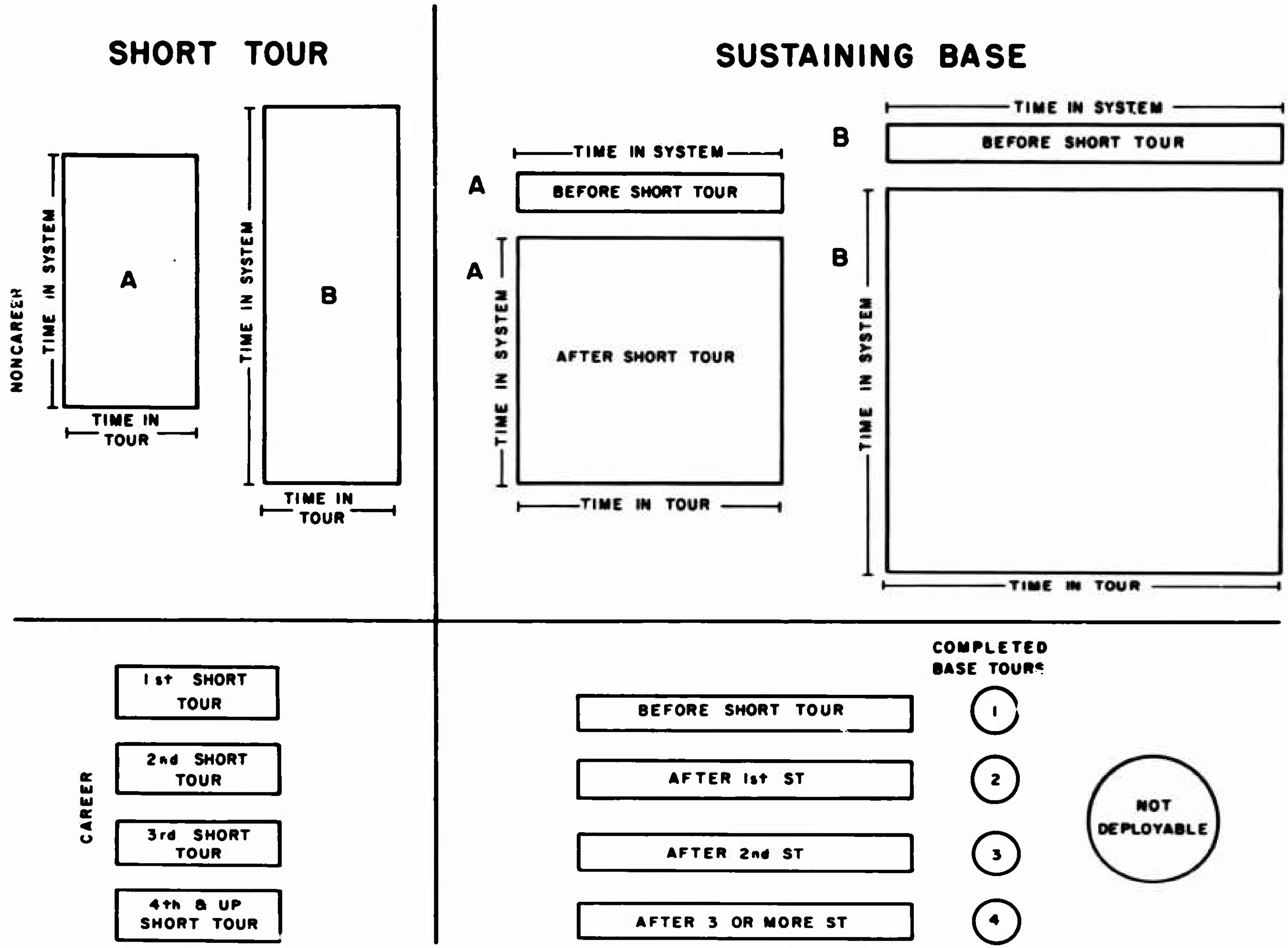


Figure 9. Career-noncareer model

Table 6

CAREER - NONCAREER OPTIONS

1. Replacement scheduling

   Smooth the flow to short tour

2. Training output

   a. Within authorization and within training capacity
   b. Maintain system size
   c. Additional as needed for rotational policies
   d. Programmed

3. Printer control

   a. Detailed output each simulation period plus
   b. Summarized output each simulation period plus
   c. End simulation summary sheet

4. Trainee usage

   a. Given another assignment if not needed in short tour; used in two short tours when required
   b. Held in assignment pool for subsequent short tour; limited to one short tour
   c. Held in assignment pool and given short tours if needed

5. Computation of returnees and average base tour for summary

   a. Career and Noncareer
   b. Career only

6. Algorithm for needed strength

   Compute number needed to allow specified rotation policy

7. In-simulation change of parameter values

8. Use of career replacements

   a. Give all returnees equal time in base
   b. Give second time returnees more time in base than first time returnees

Table 7

CAREER-NONCAREER PARAMETERS WHICH MAY BE SET BY THE USER

1.	Short tour duration
2.	Rates of temporary and permanent nondeployability
3.	Retention rates
4.	Loss rates--casualty and promotion or attrition
5.	Rate of short tour usage of training output
6.	Percent of experienced men required by short tour
7.	Length of noncareer service
8.	Length of delay before first short tour assignment
9.	Minimum base tour
10.	Desired base tour

Table 8

SAMPLE SUMMARY OUTPUT OF THE CAREER-NONCAREER MODEL

EMPHASIS:MAXIMIZE BASE TOUR LENGTH

MONTH	ST QUOTA	END TOUR	PERM CAS	ST CAS	REPL REQ	REPL SENT	NEW REPL	REY -25	2D TOUR	3D+ TOUR	AVG BS TR	ST ON HAND	NBASE -25	RETNT ADDNS	CAR TOT	INPT SCHD	ADDL INPT	ATTRT LOSS	ETS	SYST TOT
(COL)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
1	5689	117	48	21	442	442	332	0	110	0	25.0	5689	3197	34	5077	413	0	65	81	12695
2	5811	281	45	21	493	493	370	41	43	39	18.1	5811	3305	30	5039	397	0	65	72	12910
3	5808	390	46	21	478	478	359	75	86	5	21.8	5808	3330	34	5004	413	0	64	81	13132
4	5976	332	46	21	589	589	442	142	101	15	21.8	5976	3313	35	4971	410	0	65	83	13348
5	6244	349	47	22	708	708	531	176	98	26	19.9	6244	3326	40	4942	268	0	65	94	13410
6	6442	400	49	23	698	693	520	171	98	18	19.1	6442	3350	45	4920	445	0	64	108	13634
7	6524	392	51	23	569	569	427	141	20	0	18.4	6524	3459	40	4893	482	0	64	95	13906
8	6571	429	52	23	600	600	450	150	40	45	19.6	6571	3452	39	4866	495	0	65	93	14191
9	6632	287	52	24	463	463	347	116	68	0	19.8	6632	3463	32	4835	512	0	63	75	14513
10	6674	469	53	24	637	637	478	159	41	55	20.4	6674	3464	30	4798	562	0	65	73	14884
FY TOTALS		3446	484	223		5672	4256	1171	705	203	19.9			359		4397	0	645	855	
11	6922	540	53	24	923	923	692	231	113	66	21.4	6922	3405	31	4766	872	0	64	73	15566
12	6952	783	55	24	948	948	711	237	80	121	22.2	6952	3308	27	4730	615	0	66	63	15997
13	6960	373	55	25	540	540	405	135	73	22	21.7	6960	3267	34	4700	610	0	66	80	16406
14	7017	398	55	25	601	601	451	150	52	39	21.6	7017	3218	28	4663	610	0	66	66	16829
15	7094	390	56	26	607	607	455	104	34	48	20.0	7094	3185	26	4627	610	0	66	63	17254
16	7302	482	56	26	826	826	620	79	55	75	18.2	7302	3129	25	4589	610	0	68	60	17680
17	7628	569	58	26	1025	1025	769	130	75	56	18.2	7628	3073	15	4541	610	0	66	37	18129
18	7736	557	61	27	790	790	593	95	54	48	18.0	7736	3056	20	4501	610	0	66	49	18563
19	7929	418	61	28	735	735	551	81	93	45	21.0	7929	2959	39	4478	610	0	67	92	18953
20	7948	474	63	29	638	638	479	95	72	80	23.6	7948	2933	91	4507	610	0	66	214	19220
21	7948	363	63	29	514	514	386	80	51	70	23.5	7948	2901	82	4526	610	0	68	193	19506
22	7993	511	63	29	713	713	535	152	109	61	23.3	7993	2849	82	4546	610	0	69	194	19790
FY TOTALS		5858	699	318		8860	6647	1569	861	731	21.3			500		7587	0	798	1184	
23	8188	753	63	28	1135	1135	851	284	175	61	23.2	8188	2769	111	4503	410	0	68	261	19808
24	8200	780	45	29	963	963	722	241	112	122	23.8	8200	2751	107	4637	410	-999	68	252	-9999

SIMPO-I ENTITY MODEL FOR DETERMINING THE QUALITATIVE IMPACT OF PERSONNEL POLICIES (4)

Problems related to assignment of personnel to jobs or job categories form a major subgroup of problems which can be profitably studied through simulation models. The interests of manpower management offices often center on the comparison of alternative policies for assigning enlisted men to meet prescribed minimum qualification standards. Policy may specify as objectives the sequential minimization of transportation costs, an increase in the number assigned to their preferred occupational area, and optimization of expected performance on the job (as predicted from scores on paper-and-pencil tests or from other information recorded in the personnel folder). Different policies may change the order in which pertinent variables are optimized or create a need for varying degrees of partial optimization at each stage. Related problem areas which may be examined by means of a simulation model are 1) designing testing programs for personnel assignment, 2) formulating policies which change standards for enlistment and induction, and 3) estimating the impact of increased mobilization on the quality of assigned men. Analytic approaches which would handle problems of this level of complexity have been proposed (5) but have not proved economical. Results which could serve as actual solutions to these problems have been heavily based on simulation techniques.

The simulation approach is particularly necessary when some use is made of optimization techniques within the system to be evaluated. Expected output for a modeled system is often examined, for example, after simulated individuals in a sample have each been assigned to a job in such a way as to maximize the average expected performance for the sample. The assignments may be based in part on linear programming algorithms. The beneficial application of such optimization methods has been demonstrated even when the metrics which characterize a personnel system are not of the interval type assumed in the derivation of the techniques involved.

The statistical Research and Analysis Division, BESRL has developed a computer program which serves to model characteristics common to a general class of personnel functions. The model is stochastic, and the basic populations from which simulated individuals are randomly sampled is the multivariate normal, although non-random sampling resulting in non-normal distributions may also be simulated. The option of optimizing performance of a sample over multiple job categories is built into the model, and criterion indices can be related to the results of optimal allocation. Processing of manpower information may be simulated by use of linear transformations. To expand the model to contain more specific features, the computer program is written so that modifications can be easily incorporated.

Operations of the program are outlined in the flow diagram shown in Figures 10 and 11. Input of transformation matrices and parameters which determine characteristics of the system are represented in box 1. Defined are the number of samples to be simulated, the number of individuals in each sample, parameters which determine transformations to be performed on individual score vectors before and after allocation, job categories and quotas, and a starting vector for random number generation. Additional input may be read by subroutines written to expand the model (box 2).

Output consists of summary statistics computed over all individuals constituting a given sample (box 4) and also of the multiple replications which are customarily performed for a given experiment (box 5). The simulation model (box 3) is shown in more detail in Figure 11.

The "general" part of the simulation model begins with the automatic generation of a vector of random normal deviates to represent each entity or individual (box 6 of the flow diagram); on this vector are performed a series of linear transformations of the form $\underline{v} = \underline{u} K + \underline{m}$ (box 7). K may be a matrix of least-square regression coefficients for obtaining performance estimates $\underline{v}$ from a set of predictor scores $\underline{u}$; $\underline{m}$ are the additive constants to yield estimates with specified means. A special purpose for which K is used in simulation studies is to transform random normal deviates, which have an expected covariance matrix equal to the identity matrix, into variates with an expected covariance matrix characteristic of the population under investigation. As indicated in Figure 11, the user specifies the series of linear transformations required to generate a particular sample by inputting the covariance matrices and vectors of mean values and then referencing these matrices on special transformation cards, which are input in the order of the transformations to be performed. The p cards define LOOP T for computations to be performed before allocation, and the q cards which follow define LOOP T for computations after allocation.

To perform nonlinear transformations on the score vectors generated for each individual, or to perform any other operation to simulate characteristics of a more specialized system, specially written subroutines can be incorporated into operations under control of the main program. Modification and recompilation are required only for a short subprogram, not for the main program. The subroutines are assigned integer names and are called by listing these integers in the order the subroutines are to be performed on the very cards which define the sequence of linear transformations (i.e., parameters within LOOP T).

The parameter subroutines are also used to determine whether the scores being generated for a given individual are consistent with sample characteristics defined for a particular investigation. As the operations specified on each transformation card are completed, an index, which may have been set to reject a given individual by any of the subroutines, is automatically sensed by the main program (box 9 of the flow diagram). Thus, tests for individual acceptance or rejection may be performed repeatedly and at any stage in the computations.

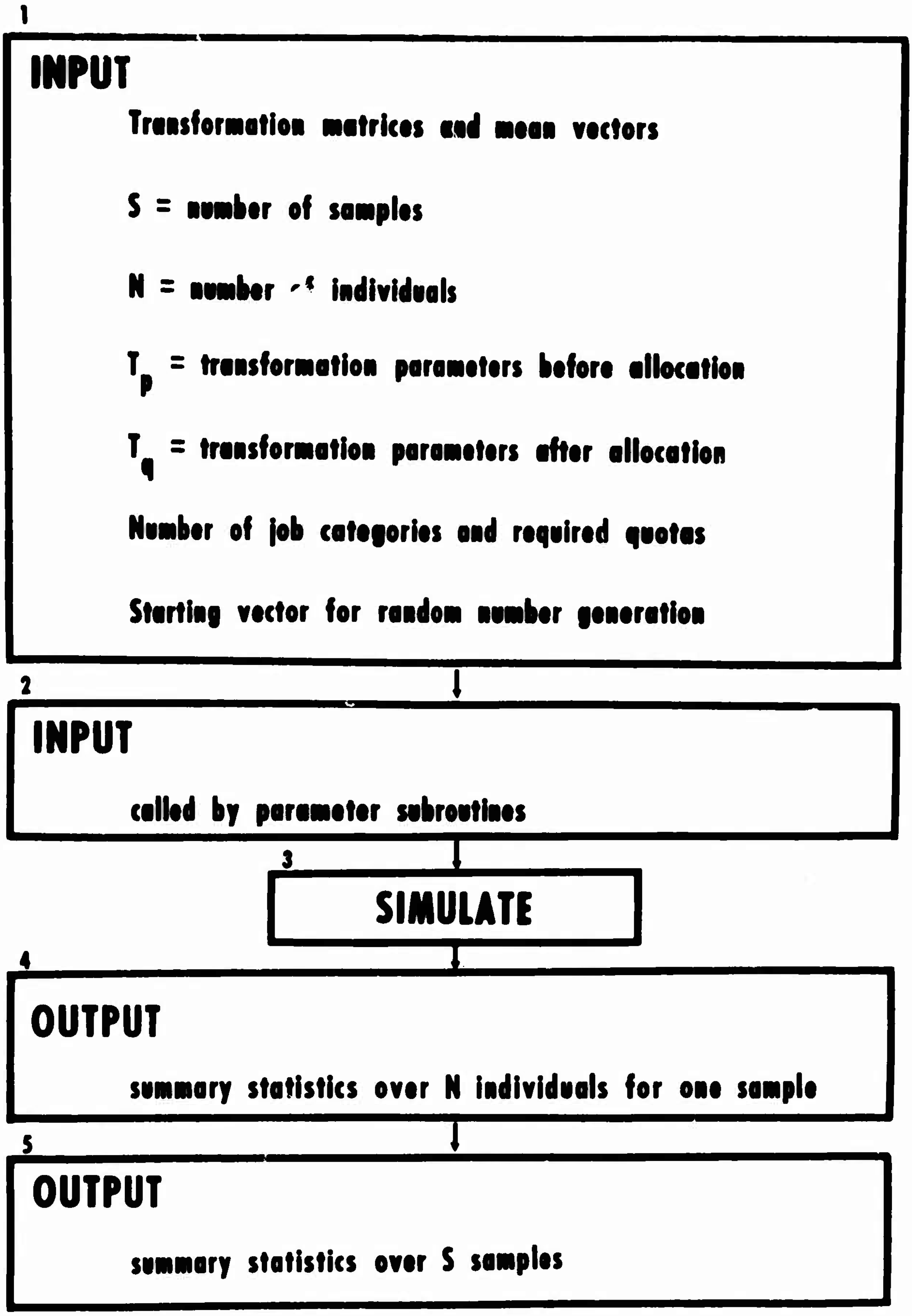


Figure 10. Flow diagram for general computer model

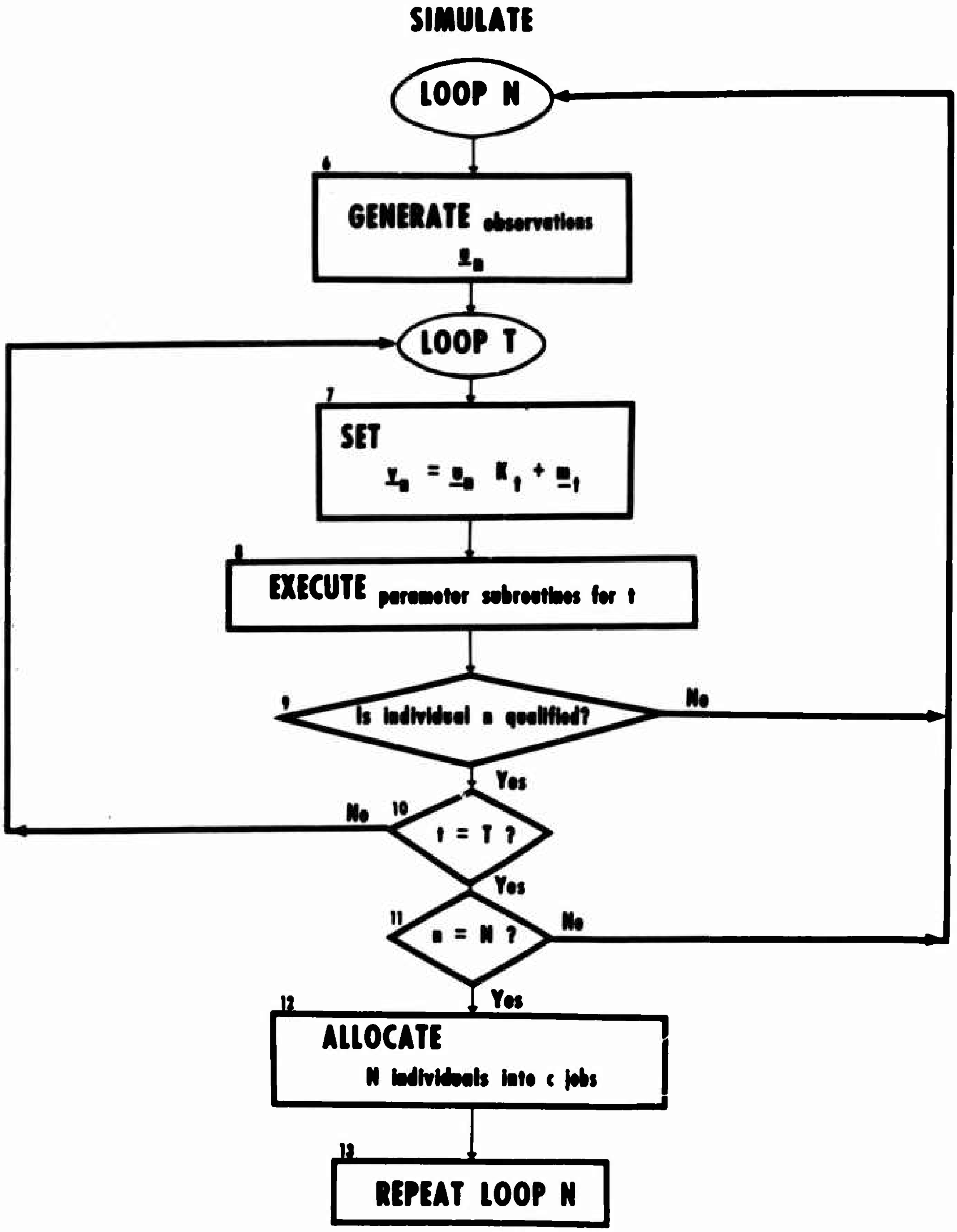


Figure 11. Simulation of personnel policies and procedures

The result of the sequence of operations specified on the transformation cards is the construction of an N x c matrix of performance measures; the c columns correspond to job categories under investigation, and the N rows represent the individuals in the sample. Based on this matrix, each of the N individuals is optimally assigned to one of the c jobs in such a way that required quotas for the different jobs are met (box 12).

After assignment, the response vectors for the N individuals are regenerated to compute statistics that are functions of the job to which each individual is assigned (box 13). These are the computations specified on the second set of transformation cards previously input and serving to redefine LOOP T. Additional parameter subroutines are included if special computations are required. (Allocation averages and frequency distributions for jobs to which men are assigned are examples of statistics used in summarizing kinds of simulation, and general routines have been prepared for computation of these statistics.) In order for simulated performance measures to represent the same individuals both before and after optimal allocation, the starting vector of random numbers is re-initialized after allocation.

Representative Applications

The purpose here is to describe typical problems for which this simulation model is well suited. Among the series of experiments which motivated development of a general program was a study by Sorenson (6) on the use of full regression equations versus aptitude area scores for the optimal allocation of enlisted men. The eleven tests of the Army Classification Battery are designed to predict performance in different job areas. However, the operating Army personnel system bases predictions on computationally simplified composites of only two tests. The purpose of the simulation was to estimate the performance gain using the full set of measures compared with the abbreviated set.

Performance estimates obtained by each of the two methods were used to allocate optimally samples of men into eight job areas such that prescribed quotas were met. The difference between the performance averages over simulated samples after optimal allocation provided a measure of differential effectiveness of the two methods of combining predictors. The gain over random allocation was roughly doubled by the use of regression equations.

Results for the published study were obtained from a specially written program, but re-analysis could now be performed much more simply because of the availability of the general program. The two kinds of performance estimate would be constructed automatically and simply within the program by performing an appropriate sequence of linear transformations on the vector of random numbers generated to represent each individual. The user would need only to input the necessary transformation matrices as data and to specify on parameter cards the order in which they are to be used.

An example of the type of simulation which would require the use of specially written parameter subroutines as well as the automatic features of the general program was reported by Sorenson at the 1966 Army Operations Research Symposium. A specially written program which did not have the more general properties of the entity model was used to obtain these results. The purpose of the simulation was to examine the effect of metric changes on the results of optimal allocation. In using the general program, performance estimates for each individual on different job categories would be constructed by linear operations similar to those used for the study just described. Each set of observations would then be modified to represent eight different metrics. Criterion estimates with an expected mean of 100 and standard deviation of 20 would be converted to two-digit integer scores ranging from 0 to 99 by subtracting 50 and truncating. One-digit scores from 0 to 9 would be formed by subtracting 50, dividing by 10, and truncating. Ordinal scales would be constructed by ranking individuals within jobs. These and other modifications would be performed by specially prepared parameter subroutines. After control was returned to the main program, an optimal allocation procedure would be performed for each type of metric, along with the computation of measures of overall performance from which the effect of the various metrics could be evaluated.

The parameter subroutines are especially useful when information is needed concerning the effect on optimal assignment of a change in the minimum requirements for entry into service. For example, scores on predictor tests (the Armed Forces Qualification Test and tests of the Army Classification Battery) can be generated to characterize samples from the mobilization population. These scores can in turn be differentially sampled with respect to the AFQT variable to depict the reality that the proportion of the source population which actually enters military service is omitted from subsequent analysis. Simulation is repeated until a specified number meet the AFQT requirement. An example is to simulate a probability of omitting 60 percent of those who score 91 to 100 on the AFQT variable, 45 percent who score from 71 to 90, and 30 percent who score from 30 to 70. The selection could be continued by computing performance estimates from the predictor scores and further restricting the sample to men who score higher than 90, say, for two or more job categories. Studies of this kind have been used to recommend policies to the Army concerning changes in input requirements for enlisted men in the context of a particular deferment policy.

One particular application involves obtaining estimates of overall job performance as a function of various restrictions on the incoming population at a fixed point in time. For a different type of study, interest might be in overall performance when various restrictions are made on personnel as they operate within the system over an extended period of time. This is, performance at different stages of experience is simulated. In the field situation, samples constructed on the basis of training experience are usually composed of different sets of individuals because of difficulty of doing follow-up studies on the same men. In a simulation study, however, performance for the same individual can be followed through the complete time cycle. This follow-up is accomplished by first inputting transformation matrices which yield expected means, variances, and covariances for men who have t_1 months of experience, t_2 months of experience, up to t_k months of experience. The vectors of random numbers generated for each individual are then post-multiplied by these matrices, maintaining the same random numbers each time a given individual is represented over time.

At the start of the simulation, individuals in a sample are optimally assigned over c jobs on the basis of criterion performance. During the first t_1 months, each of the N individuals is examined for possible loss from the system. This loss may be a function of an individual's estimated job performance, simulated events occurring within the system, a random process which determines that near to p percent of the sample will be lost, or some combination of these variables. Functions which determine loss are added to the program as parameter subroutines and may differ for the different job categories and for the number of months an individual has served.

For each individual remaining in the system, new performance measures appropriate to his job assignment and the length of time he has spent in the system are simulated. To replace men lost to the system, new random numbers are generated and transformed to expected values for an inexperienced population. Assignment to different job categories is performed such that expected performance of the new sample is optimal and job quotas reduced by loss are restored to their original values.

At the end of each point in time, t_i, the effectiveness of the system is evaluated. The evaluation may be as simple as computing the average measure of job performance for the different job categories; or it could involve a fairly complex function of the performance of crew members where a weapon system is involved. Simulation then proceeds from time t_i to time t_{i+1} by again testing observations for the N individuals for loss or retention in the system and by generating new observations to represent enough inexperienced personnel to fill the losses. At the end of the kth simulation run, representing the passage of t_k months, simulated observations will represent individuals with time in service ranging from zero months to full length of the tour.

With this type of simulation, quality of predicted performance in the system can be examined as the proportion of experienced personnel in the system increases. In addition, the rate or change in rate at which men are lost from the system can be related to system performance. Experiments which investigate constant loss rates over all jobs may be specialized to examine varying patterns of loss rates for different jobs. Research of a more technical nature might involve comparison between different approaches to optimal allocation. Optimal assignment of the incoming sample can be based only on performance estimates of men in that sample. A different approach would take into account performance estimates of the total sample, including the experienced personnel, when determining initial assignment of incoming personnel.

SIMPO-I GENERAL MATRIX MANIPULATOR

DYNAMOD was developed as a flow model which could have as large a number of nodes as might be required by the system being modeled. Each node was represented by a vector in which the jth element denoted the number of entities who had been in the tour j months. The General Matrix Manipulator (GMM) was designed to have the general features of the DYNAMOD models, but with matrices rather than vectors at each node. Thus, the ijth element of a matrix node in the GMM contains the number of men who have been in the system i months and in the tour j months.

Flexibility to permit the policy maker to try any reasonable policy change is an essential characteristic of SIMPO models. For example, the order of making assignments has a most definite effect on the personnel configuration resulting from a simulation run. Rules on transfer of persons in the system must be easily changeable to provide for evaluating the effect of adding a new rule or reversing existing rules. New emergencies may arise with changed force structure requirements. New tours may be created or existing ones may have new duration. Or the Army reserves may be added to the active duty forces, the resulting qualitative changes differing markedly from the levels occurring when only training outputs enter as input to the distribution sub-model.

The GMM is a disc-based mass flow model which provides for maximum flexibility during the simulation. The following variables can be changed either at a specified time or through an event occurring during the simulation:

1. Priority of fill rules
2. Number of tours
3. Number of subtours
4. System and/or tour requirements
5. Loss rates for tours
6. Promotion rates for tours
7. Duration of tours
8. Length of commitment

The GMM simulation model has been referred to colloquially as the GRAND Model because of its numerous complexities as compared to DYNAMOD. Models developed in this family are now designated as DISTRO and the General Matrix Manipulator.

The General Matrix Manipulator (GMM) is best thought of as a collection of matrix nodes connected by a flow network in which the flow is governed by capacities of the nodes, number of rows and columns in the matrices (i.e., length of tour or commitments), and the priority of fill rules. Deletion of an entity from one node coupled with its appearance at another node is accomplished by one or another of several flow types. These flow types differ from each other in terms of how the loss to an element in matrix C results in an addition to an element in matrix D. Denoting the losing matrix (node) as C and the gaining matrix (node) as D, the flow types can be described in terms of the element in D which gains from a loss in C. These relationship are shown below:

Flow Type	Element losing in c at time t	Element gaining in D at time t + 1
1	$c_{i,j}$	$d_{i+1,j+1}$
2	$c_{i,j}$	$d_{1,j+1}$
3	$c_{i,j}$	$d_{i+1,1}$
4	$c_{i,j}$	$d_{1,1}$

The nodes in a GMM can be thought of as located on a grid on which locations are specified by tour and level (grade, rank, or skill). When more than one node is located at a grid location (as when several MOS are interchangeable in one tour but not necessarily so in other tours), these nodes are considered subtours of the same tour. The flow upwards to higher levels within a tour constitutes the familiar feeder pattern while the flow across tours at the same level depicts the rotation phenomenon.

Two kinds of node are envisaged for the GMM--not necessarily for the same application, but one type for one application and a second for another. In one type (A), one dimension of the basic node matrix represents time in location (tour or command) and the other dimension time in system (time in the Army). In a second type (B), one dimension represents time in grade or skill level and the other time in service. Thus, it will be possible to consider abstracted promotion problems or rotation problems using the same basic set of programs. These two types of node are shown in Figure 12.

Since it is possible to have multiple nodes at a location, some combinations of promotion and rotation problems can be considered, or more than one MOS system may be considered at a time. In DISTRO, an MOS family is being modeled with advancement from one skill level to another and rotation between tour areas. Figure 13 shows type 1 and type 2 flows. These flows involve adding the amount taken from a feeder node to the equivalent cell of the gaining node. Neither time in service nor time in command changes as a result of the change. Prescribed proportions can be taken from each row (representing those with equal time in service).

A Type 2 flow is implemented by adding K persons to a cell in the gaining node that corresponds to the first column (least time in command) and the same row (time in service) as the row from which the K persons were removed in the contributing node. Each cell in the matrix would then be advanced one place by row and by column. This flow represents the most typical flow found in SIMPO flow models. Nondeployability

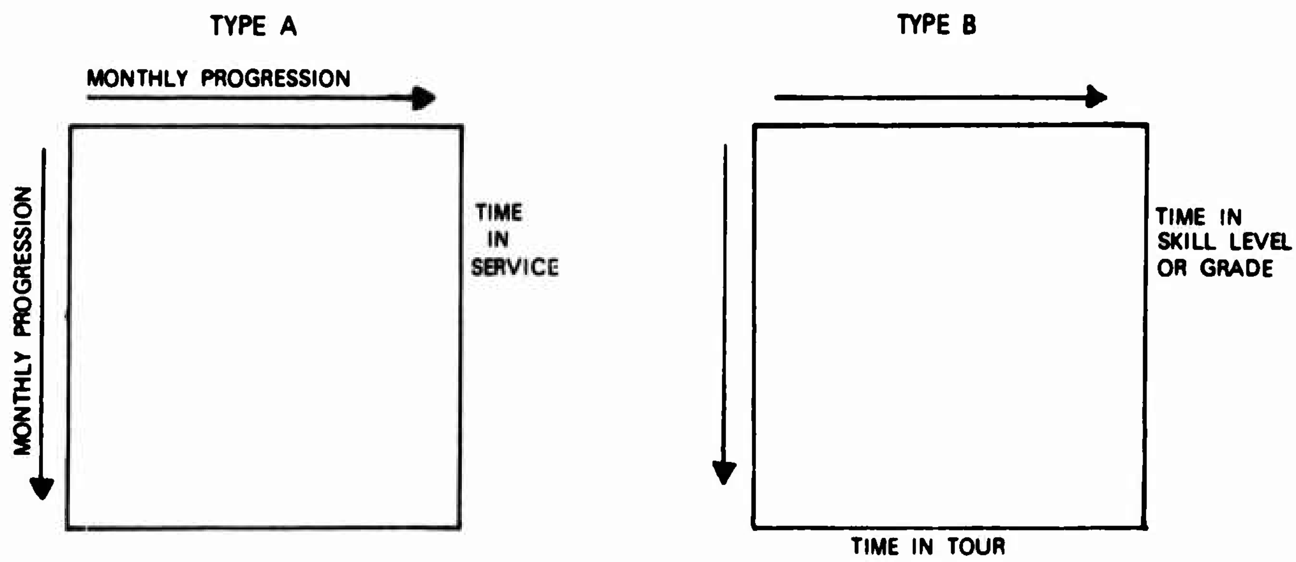


Figure 12. Node types in General Matrix Manipulator (GMM)

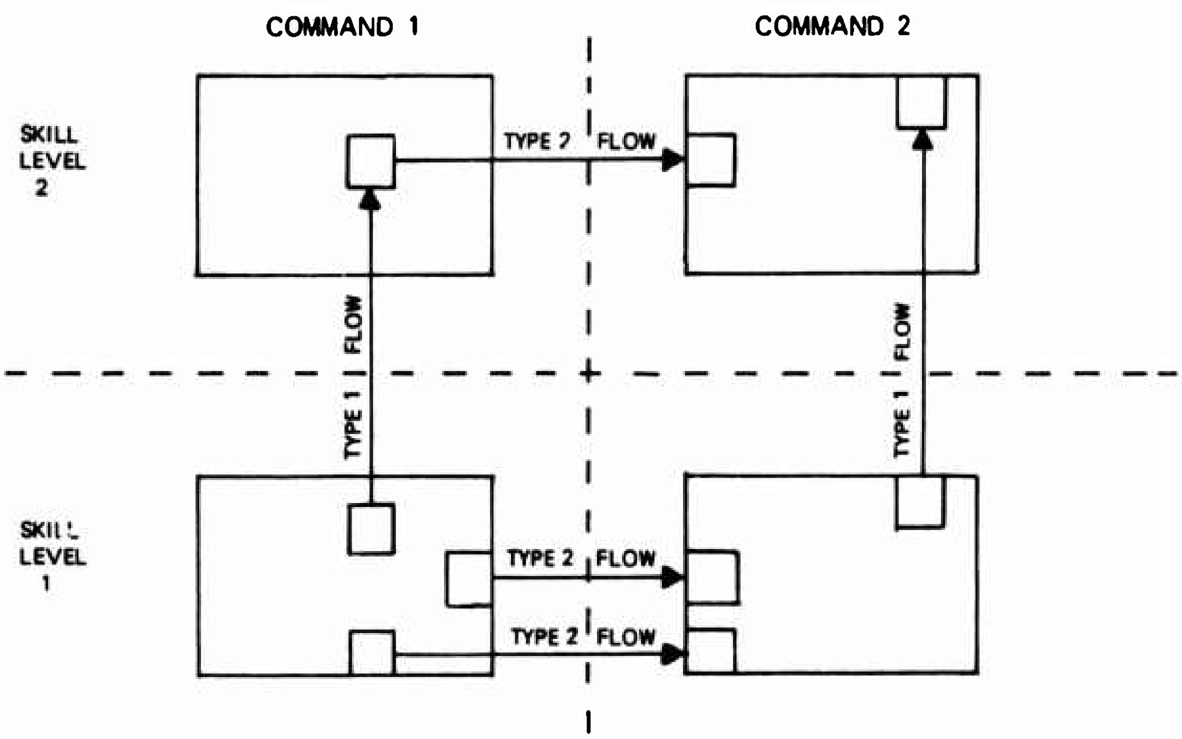


Figure 13. Type 1 and Type 2 flows in the General Matrix Manipulator (GMM)

constraints relating to rotation status are imposed on this flow. In a distribution model having both Type 1 and Type 2 flows, more detailed distribution of assets to claimants could undoubtedly be made after the Type 1 flows and before the Type 2 flows. The rate of fill (constraints on flow into nodes) at each command aggregation could then be recomputed to reflect distribution priorities. These fill level requirements reflecting distribution priorities would in turn determine desired levels of fill for the Type 2 flows. However, the flow policies and network characteristics of the problem posed for PRIMAR/SIMPO by CAD would appear to permit reflecting distribution priorities for overseas claimants in the Type 2 flows and could permit distributing assets within CONUS at any time, independent of the rotation logic.

Figure 14 shows Type 3 and Type 4 flows. A Type 3 flow is a flow within a command via the feeder pattern among Class B nodes. These nodes have time in node (grade or skill level for MOS or branch) as the vertical dimension of the matrix and time in command (tour) as the horizonal dimension. The Type 3 flows have the effect of resetting time in node to zero and retaining the column location (time in command) of the receiving cell. This type of flow would probably be the most appropriate type to depict an officer promotion policy.

Type 4 flows are included here for the sake of completeness. The Type 4 flows would place all input into a node at the upper left-hand cell (with time in grade and time in command both set at zero), and would represent a promotion to fill a vacancy located in a different command.

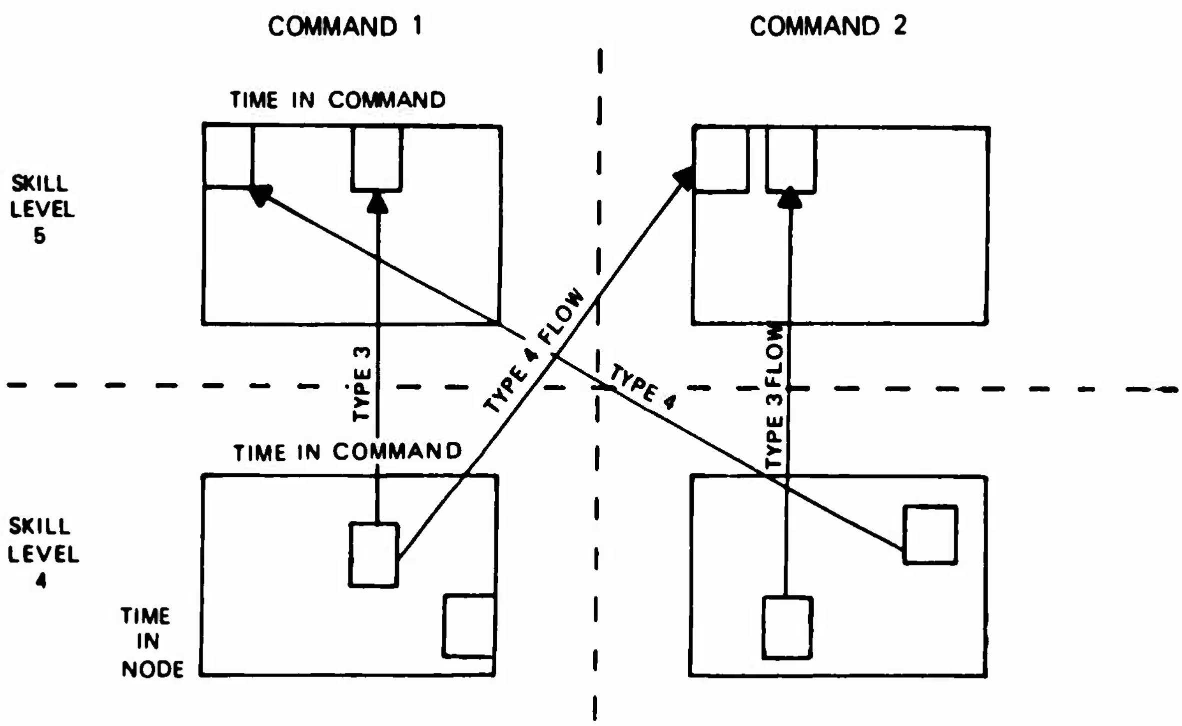


Figure 14. Type 3 and Type 4 flows in the GMM

DISTRO: SIMPO-I APPLICATION OF GMM FOR ESTIMATING DISTRIBUTION CAPABILITY UNDER POLICY CONSTRAINED DEPLOYMENT

In addition to projecting the assets which will be available in the various MOS systems 24 months in the future, distribution and procurement sections of DCSPER and OPO must make some estimate of Army distribution capabilities for the same period. This estimate is now obtained by first making the inventory projection and then distributing the number expected to be in the system (less a percentage set aside to represent transients, patients, students, and prisoners) according to priority rules set up by Army management. The current distribution report does not take into account such deployment constraints as minimum allowable rotation base tours before involuntary return to overseas, or a lower limit on the time before ETS (expected date termination of service) for overseas assignment. Nor does it (in its present form) place a floor on manning levels for lower priority tours when an MOS system is so short that the Priority I tours cannot be filled to 100% of requirements. Consequently, an especially constrained MOS may be shown with all its assets in the Priority I tours.

Because the present method used for making the distribution report results in a distorted estimate of the Army's ability to meet world-wide requirements set for it by the Department of Defense, the DCSPER officers responsible for the report have designated a distribution-capability forecasting as providing the most realistic evidence of the extent of policy-caused nondeployability and its effect on readiness. A mass flow rotation model has been designed which can be used in testing many deployment related policies.

Model Concepts

For modeling purposes, the command elements have been categorized into four main groups: hardship, long tour, stabilized, and rotation base.[1] Within each

[1] Alternative approaches could be used in fitting an MOS system into a mass flow model. It would be possible to model each of the separate command elements, set up rules of flow, and accept the output of the model at given intervals as the distribution possible under given conditions. Flow to similar tour areas would have to be directed by mathematical relationships. Suppose, for example, 100 men in CONUS are available for assignment to long tour. There are two long tour areas: Europe and Alaska/SouthCom. Suppose Europe needs 150 men to come up to 50% of requirements, the desired rate of fill, and another area in the same priority, Alaska, needs 75. Suppose further, the full authorization for Europe is 1000 and for Alaska/SouthCom is 600. The model would have to provide for using assets equitably. In this instance, the computer would probably be required to solve the equation

$$\frac{350 + x}{1000} = \frac{325 - x}{600}$$

for x, then assign x men to Europe and 100 - x to Alaska/SouthCom. In the other alternative, only one long tour area would be modeled and a routine provided at the end of the simulation to make distribution of the men in long tour to each of the separate commands, again maintaining the same rate of fill for similar areas. In either instance, consideration would be made by the computer to assure that similar areas share equitably and that final results displayed in the computer printout are the same. To allow consideration of policy changes, a compromise between representing only short tour, long tour, stabilized, and other CONUS on the one hand or representing each separate command on the other may be the best solution. This compromise might consist of representing specifically each different length tour in each of the four categories; or it could consist of representing each separate priority in each grouping.

group, career men and two types of noncareer men are represented. Additional representation is made in rotation base for prior overseas service. Each separate tour classification is represented by a matrix in which one dimension is time in tour and the other is time in service. A diagram of the model is shown in Figure 15. Connections between the tours are to be set up in agreement with present rotation restraints. A general diagram of the DISTRO flows is shown in Figure 16. Priority I tours will be filled as nearly as possible under given operating rules. Priority II tours will then receive the remaining deployable assets up to requirements unless stopped by limitations placed on the manning level of the low priority tours. Tour durations, service commitment, ETS, and rotational restrictions on personnel assignment, and retention, loss, and deployability rates are all parameters which will be supplied by the analyst for each computer run. Thus, to find the effect of changing the length of the Vietnam tour, for example, the analyst would have to prepare two runs of the model using the same values for all parameters except the Vietnam tour length. Output of the model will show distribution capability under the policy being considered.

A. Rates of fill

Priority I, II, III = r_1, r_2, r_3, respectively

B. Tours represented

12 mo ST	=	ST1
13 mo ST	=	ST2
Long Tour	=	LT
Stabilized	=	SB
Before OS	=	C1
After ST	=	C2
After LT	=	C3

C. Priorities of assignment

INTO		FROM	AFTER
1. ST1 and r_2 * ST2	see algorithm below in Section E	C1	5 months
		C3	25
		C2	25
		SB	25
		SB	18
		C3	18
		C2	18
		C3	12

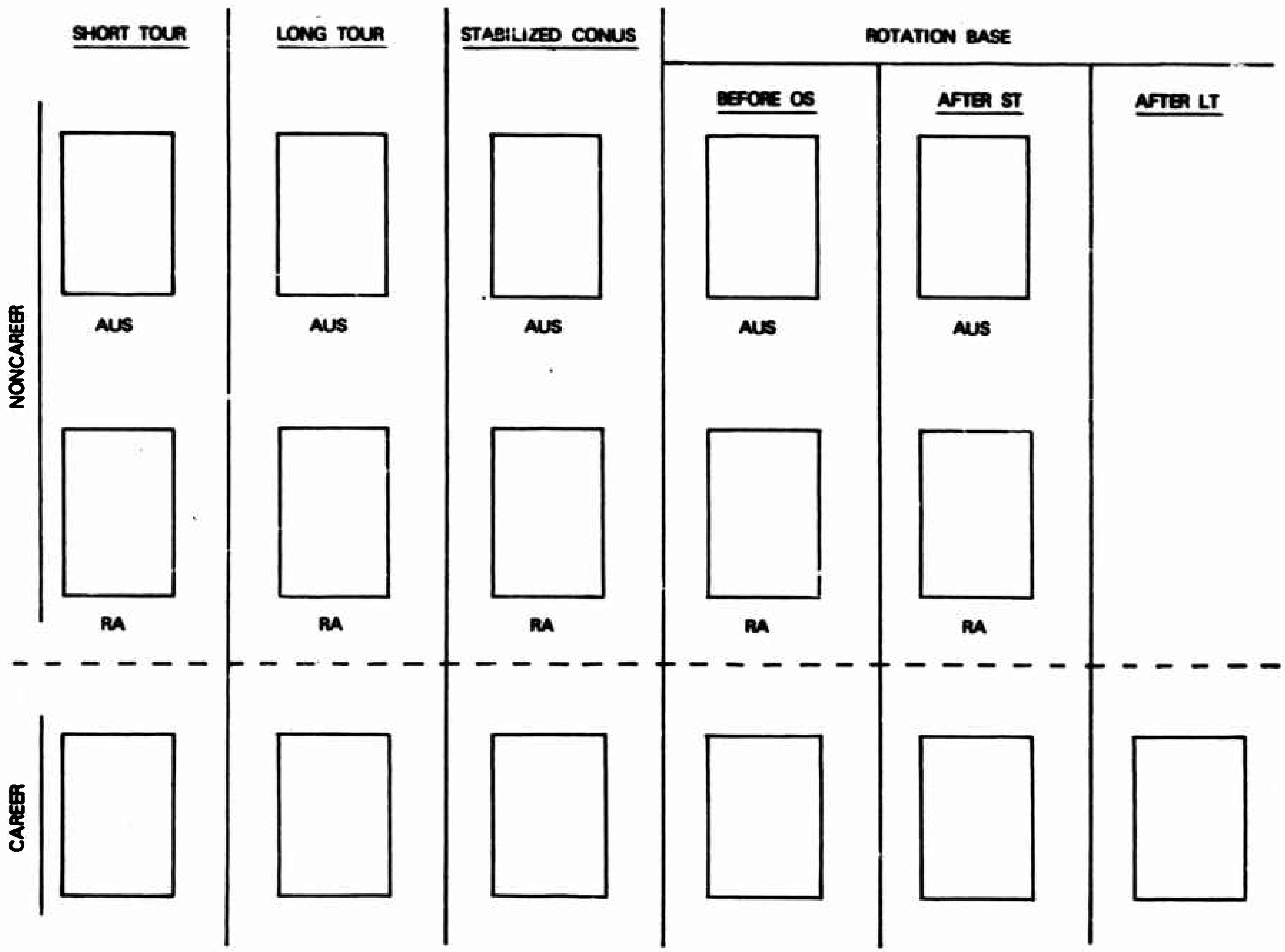


Figure 15. DISTRO: Distribution-Rotation Model

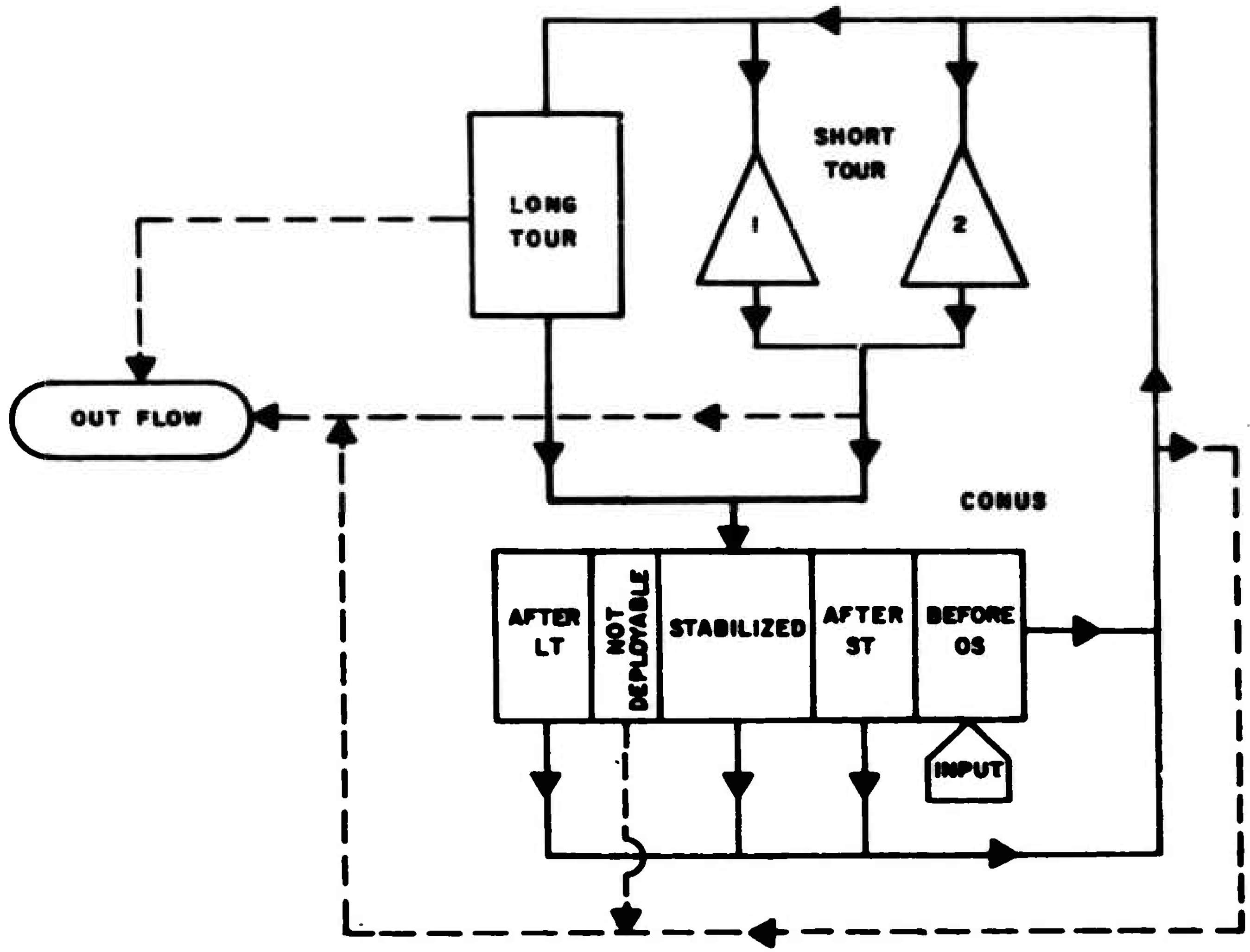


Figure 16. DISTRO Flows

C. <u>Priorities of assignment - cont'd</u>

INTO	FROM	AFTER
2. LT * r_3	C1	5
	C3	25
	C_2	25
	SB	18
	C3	18
	C2	18
	C3	12
	C2	12
3. SB	ST1	12
	ST2	13
	LT	36
	C2	25
	C2	18
	C2	12
	C3	25
	C3	18
	C3	12
	C2	3
	C3	3
4. C2	ST1	12
	ST2	13
5. C3	LT	36

Test: Add C1, C2, C3, and SB for months K and up to last minus number of months' transiency simulated. (Where K = number of months' transiency simulated + 1.) If number in CONUS tours is less than $\Sigma\ r_i\ A_i$, stop searching; if greater, continue to 6.

C. Priorities of assignment - cont'd

	INTO	FROM	AFTER
6.	ST2 (up to r = 100%)	C1	5
		C3	25
		C2	25
		SB	25
		SB	18
		C3	18
		C2	18
		C3	12

Repeat Test. If $\Sigma\, r_i\, A_i$ for the CONUS tours is still less than the number in CONUS, continue to 7.

7.	Into LT (up to 100%)	C1	5
		C3	25
		C2	25
		SB	18
		C3	18
		C2	18
		C3	12

D. Temporary nondeployability factor, 50%

E. Algorithm for assignment to ST1 and ST2, Section C 1.

Required to bring ST1 to 100% = NEED1

Required to bring ST2 to r% = NEED2

where r = rate of fill

Available for assignment = N

Assign to ST1 $N * \frac{NEED1}{NEED1 + NEED2}$

Assign to ST2 $N - [N * \frac{NEED1}{NEED1 + NEED2}]$

Distribution Algorithm

Distribution rules depend upon the decision of Army management. However, for a first approximation, use the following:

Suppose for each tour area (1 to 4) the command elements (CE), authorized strength (A), priority of fill and rate of fill (r) for the given priority are known. (Parameters to be read in.) Retain in memory.

$_1N_i$ = number in ST1 for month i

$_2N_i$ = number in ST2 for month i

$_3N_i$ = number in LT for month i

$_4N_i$ = number in CONUS in month i who have had 2 to m - 1 months in tour

Distribution rules go like this:

1. Multiply $_jN_i * (1-p)$, where p is the rate of patients allowable, to obtain $_jN_i'$.

2. Assuming $\sum_{k=1}^{\ell} {}_kA_i * {}_kr$, where ℓ is the number of command elements in tour j, is known, test $_jN_i' - \sum_{k=1}^{\ell} ({}_{jk}A_i * {}_{jk}r)$.

   If $_jN_i' > \sum_j {}_kA_i * {}_jk^r$, assign $_{jk}A_i * {}_{jk}r$ to Element jk, obtain the difference and call it surplus.

   If $_jN_i' < \Sigma$ Ar, solve for factor x which may be used to divide assets proportionally among the ℓ tours.

   $_jN_i' = X * \Sigma$ Ar and assign $X * {}_jk A_i * {}_jk^r$ to command element k.

The assignments made to each command element is the manning level (ML) and will be printed out for each month. Additionally, there should be a printout of parameters to include tour lengths, deployability rates, lag times, and rates of fill used.

Required Data Base

A simulation model which is capable of producing detailed information requires a correspondingly detailed data input or an extensive mathematical description of the relationships between various relevant aspects of the system in order that usable data may be developed by the model. For such a rotation model as is planned, we must know for each MOS simulated how present assets are classified by time-in-tour within time-in-service within each career or noncareer classification for each of the tours represented. The logical source of this information is the Enlisted Master Tape Record (EMTR). However, the required information is not available from extract tapes at the present time. In order that an adequate projection of capabilities can be made, provision must be made for obtaining this information in machinable form from the appropriate agency or copies of appropriate tapes must be obtained using existing routines with appropriate modifications or special extraction routines.

ODCSPER CAD has spent extensive time providing even the limited information now available for the example being modeled: For a single MOS family (11B1, 11B2, and 11B4) there is a gross inventory of men in each of the command elements used in the Distribution Report broken out by component (AUS and RA first termers and career RA). There is no information on time-in-tour or time-in-service for those on overseas duty. Limited information is available on time-in-tour for short tour returnees (by six-month blocks) and no information on time-in-service for those in CONUS assignments. The number in each 4-digit MOS whose ETS falls in a given month is tabulated by the extract routine used for other models (these numbers are available), but expected additions from OJT are unknown quantities. Since constraints on deployment of new men or on men close to ETS are specific, a more comprehensive inventory is needed than is now available. One approach to eliminating the uncertainty on OJT additions might be to combine appropriate 4-digit MOS into a single system so that additions always are new trainees and time of entry into service defines time of exit from the system. Also available is information on command element authorizations and requirements and computer generated input requirements. For a demonstration of the proposed model, some liberties have been taken with available information in the development of necessary data input.

Rules of Movement

The following rules of movement were obtained from the Capabilities and Analysis Division:

1. Movement time from receipt of orders to movement is three months including one month transient time; that is, from the time a group is ordered to the short tour, three months will elapse before it arrives in ST.

2. Transient time for moves from overseas to CONUS is one month.

3. Two months' delay from graduation from AIT until the individual can be ordered to ST. (Thus, for individuals ordered to CONUS and then to ST, total time to reporting is five months, combining time in 1 and 3.)

4. No movement between short tours.

5. Long tour 1st term assets in Europe must serve six months before they can be sent to short tour.

6. No one stays in any command longer than 36 months.

7. Alaska and SouthCom are not part of sustaining base.

8. STRAF 1 forces are deploying units and are not part of sustaining base.

Assessment of DISTRO Coverage of Assignment Constraints

Table 9 shows the causes of nonavailability for overseas assignment and, wherever possible, a mean value over time for each category of the overall sustaining base available for reassignment. The means were obtained from reports on nondeployables as of June, September, and November, 1967 and February 1968. The first category, transients, is represented for new trainees as delay after entry into the system before assignment to duty. Returnee transient time is represented by extending stabilized tours by an appropriate number of months and increasing quotas correspondingly or by omitting individuals in the same constant number of periods from possible manning levels shown for other rotation base tours. The second grouping of nondeployables, students, can be specifically represented by providing a fixed length tour for the MOS school with specified requirements, student origins, and destinations. In the present problem, no school is represented. Patients are represented within the factor of temporary nondeployability to be applied to those assets presumably available for reassignment.

Table 9

NONDEPLOYABILITY FOR OVERSEAS ASSIGNMENT

Category	M
Transients	10
Students	10
Patients	1
On orders	3
ETS imminent	20
Insufficient time after overseas	6
Stabilized assignment and miscellaneous personal attributes	13

The next category, on orders, calls for some compromise. Mass flow models previously developed by BESRL have had no provision for representing issuance of orders some months prior to actual assignment except in the instance of maintaining a delay between training and first assignment. The same approach is taken in DISTRO. Transfers for persons already in the career system are depicted as instantaneous, as are also transfers for those in the noncareer system with more time in service than the specified delay. The next two categories, ETS and time after short tour, are represented explicitly. Stabilized assignments can be represented explicitly by having a tour of fixed length for the specified number of stabilized positions. The last category, miscellaneous personal attributes, is a catchall classification covering "sole surviving son," compassionate deferments, previous moves in the same fiscal year, and other reasons. The category is represented in the model in the factors of permanent and temporary nondeployability.

An additional aspect of the problem of finding replacements for men completing duty tours is the difficulty of obtaining good data on available assets. This problem is being attacked by the Army, and improvement of the data base probably will follow. However, some lag in information is inevitable, and DISTRO must provide coverage for slow system reaction time. Since no good way to handle this aspect of nondeployability seems available, the temporary nondeployability factor is used again.

The DISTRO model covers approximately 80 to 85 percent of the nondeployables shown in Table 9, with additional provision for a factor to cover the remainder of the categories shown in the OPO reports combined with estimated errors in the EMTR.

SIMPO-I GENERAL ENTITY SIMULATOR (GES)

BACKGROUND

As a conclusion to the models developed in SIMPO-I, and to offer coverage of system detail required by study of interacting personnel policies, an entity modeling capability was indicated. When an entity simulation capability is required, at least three alternatives are available: design and program a simulation to meet specific problem needs using a general purpose language such as FORTRAN; use a special purpose simulation language such as SIMSCRIPT or GPSS and write a program to meet specific needs; or use a general purpose language and write a general purpose simulator--a system of modular, interactive, and flexible subprograms which may be shaped to the particular system under study with minimum effort by the systems analyst. The criterion used in choosing the alternative selected was assessed efficiency of initial design and programming effort. The last of the three alternatives has high initial development investment but relatively low cost for subsequent problem applications. If many problem applications are anticipated, then the high initial cost is offset by the relatively low cost of later uses.

The development of the General Entity Simulator (GES) was based on the premise that through use of such a mechanism a majority of the personnel problem situations amenable to modeling could be efficiently and effectively modeled. Effective study of many of the personnel management problem areas requires the detail that can be provided by entity simulation. Concept of the simulation system is shown in Figure 17.

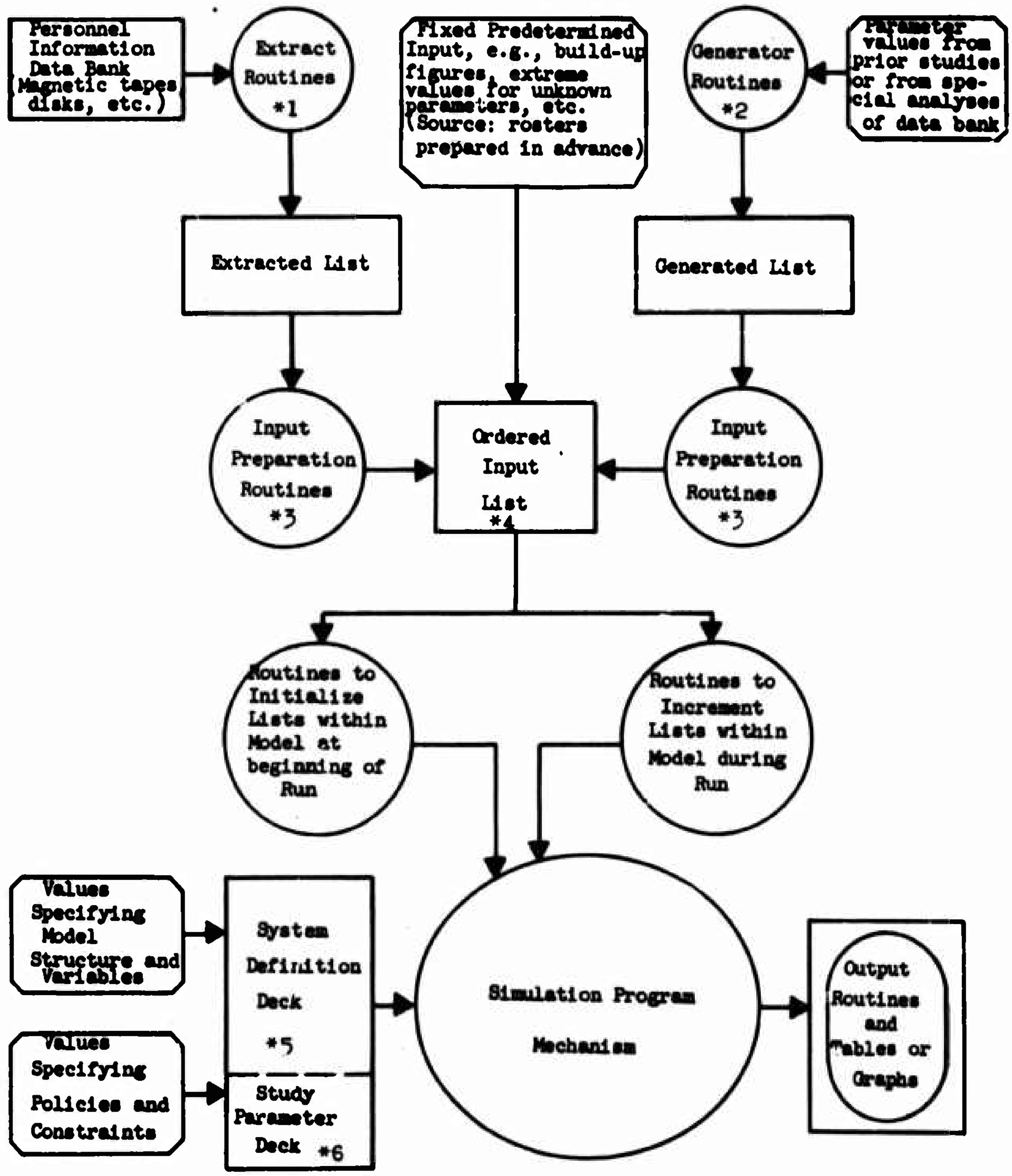
GES APPROACH

The General Entity Simulator was required to be able to model a wide variety of personnel problems by inputting data cards which controlled the routines used, the sequence of their use, parameter values, system priorities, and so on. These cards would be prepared by a person not necessarily familiar with computer programming, but very familiar with the personnel system under consideration and capable of following instructions from a program user manual.

In order to accomplish such a program system, it was necessary to develop a structure to which all or nearly all personnel situations could relate. Problems in personnel rotation have elements in common with problems in personnel promotion, training, or accession. Nearly all problem situations can be represented in terms of the flow of personnel in a network. The network is a series of nodes with flows between the nodes, and constraints on these flows caused by policies regarding the use of personnel. To execute a simulation problem, the analyst must describe the nodes, the entities, and the policy parameters contained in the rules used in the particular problem situation. The descriptions are then translated into preset codes, data cards prepared, and appropriate entity records supplied. A system simulation is then ready for the computer.

The GES Program System

GES is made up of three kinds of component--retrieval, logic, and utility. Retrieval components are concerned with searching the files and retrieving entities with specified attributes. Since these operations take place many times during the course of a simulation, an efficient method is very important. GES manipulates data in bit notation rather than in computer words. In this way, available in-core storage is significantly increased. Conceptually, a data file representing an attribute of a characteristic, (e.g., E7 is an attribute of the characteristic, Grade) may be described as several layers of "bit matrices" superimposed on one another, where each bit position in the top layer indexes a particular record number and all layers taken together define the value of the attribute in binary form. This structure eases the task of searching out the set of entities all of which have a particular set of attribute values for a given set of characteristics. Using Boolean algebra principles, various characteristic files can be quickly masked into a single bit matrix which has "on" bits in positions corresponding



*1 May include routines for selecting all persons with prescribed characteristics, as well as sampling routines to simulate such activity as volunteering.
*2 Random number generators and transformation routines for creating random samples from populations with prescribed multivariate characteristics.
*3 Including sorting, censoring, selecting, distributing routines, etc.
*4 e.g., all Captains ordered by date of rank forming a queue awaiting entry into a model for Majors.
*5 This deck is set up by the simulation model designer who also will write a manual describing how to use the study parameter deck.
*6 Defines policies to be evaluated, contingencies to be depicted during a study, variables to be systematically varied by the experimenter (management or OR analyst), and dimensions of study (i.e., number of replications, interlocking runs, etc.).
Circles and ovals represent programs, rectangles represent information in machinable form, and octagons represent information in other forms.

Figure 17. Basic Concept for the General Entity Simulator

to records which have the desired attribute values for all characteristics under consideration. It is then relatively simple to count the bits or to go to the individual records so identified for additional information.

In addition to the basic retrieval programs, there are other efficient routines to build and update the entity files. The file building program will accept a base personnel data file in almost any format and build an entity file acceptable to the GES model.

The second set of components is the logic subroutines. These contain the decision rule algorithms for promotion, separation, procurement, assignment, and skill changes. These algorithms represent the procedures now used by Army management to perform these functions. Within each routine, there are certain variables whose values must be set by the analyst, i.e., policy parameters. For example, in making short tour assignment, consideration is given to the amount of time that has elapsed since the last such assignment. A set of alternative policies may differ from each other with regard to the effect of lengthening or shortening the duration of short tour. Both of those variables are considered in the assignment logic and their values set by the analyst as a policy parameter which must be defined for each experimental run of the model.

Each of the logical component algorithms has a set of policy parameters associated with it. In a particular simulation, it is possible to eliminate some of the logical algorithms or to fix their parameters while examining a particular policy type. If only promotion policies are to be studied, it may be desirable to eliminate procurement or assignment routines. This can be done by use of a data card.

The last set of components is made up of utility routines. In designing the logic components, it was found that some operations were repeated. These operations were concerned with the entity file (retrieving a fixed number of entities, changing characteristics, sorting, making random selection, and so on) and disk operations (reading from and writing on the disk). General routines were developed that made unnecessary recoding separate repeating situations. In using the GES system, the analyst user cannot access the utility routines directly. However, if new logic routines are to be added or if revisions are necessary for the present routines, the availability of the utility routines to the programmer making changes will make his task much easier.

Macro Design of the GES

The design of the GES flow mechanism may be seen in Figure 18. This system divides into four main parts. The first of these is the file builder including initialization of the binary attribute files. The second is the executive routine which controls summarization of data and reporting. (The executive routine also controls system and policy changes and causes time determined system changes to take place.) The third section contains the system and policy changes, which can be either stochastic or deterministic. Subprograms update the appropriate files accordingly. The last portion of the flow chart covers system time-determined changes.

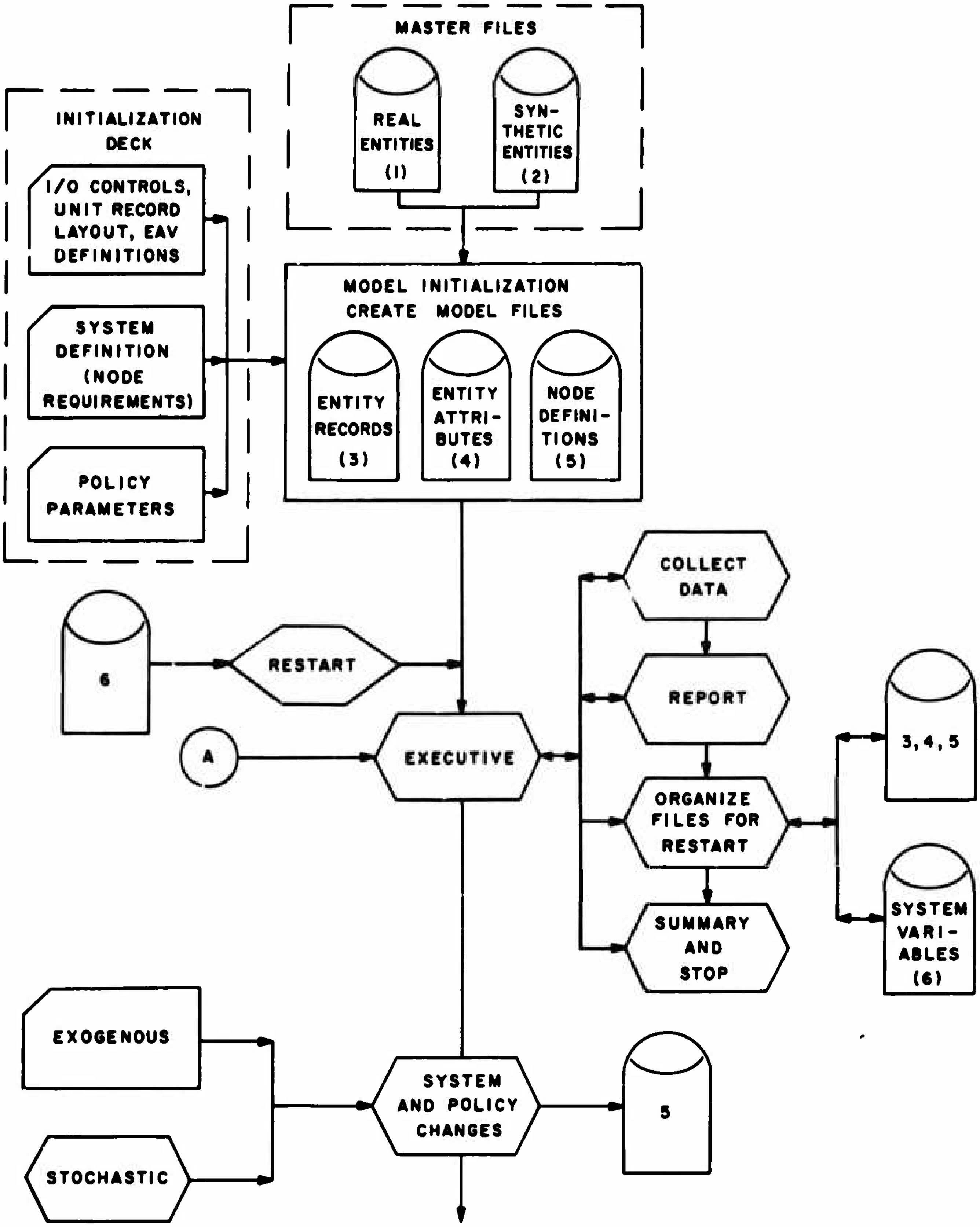


Figure 18. SIMPO-I General Entity Simulator: Macro System Design of entity flow mechanism

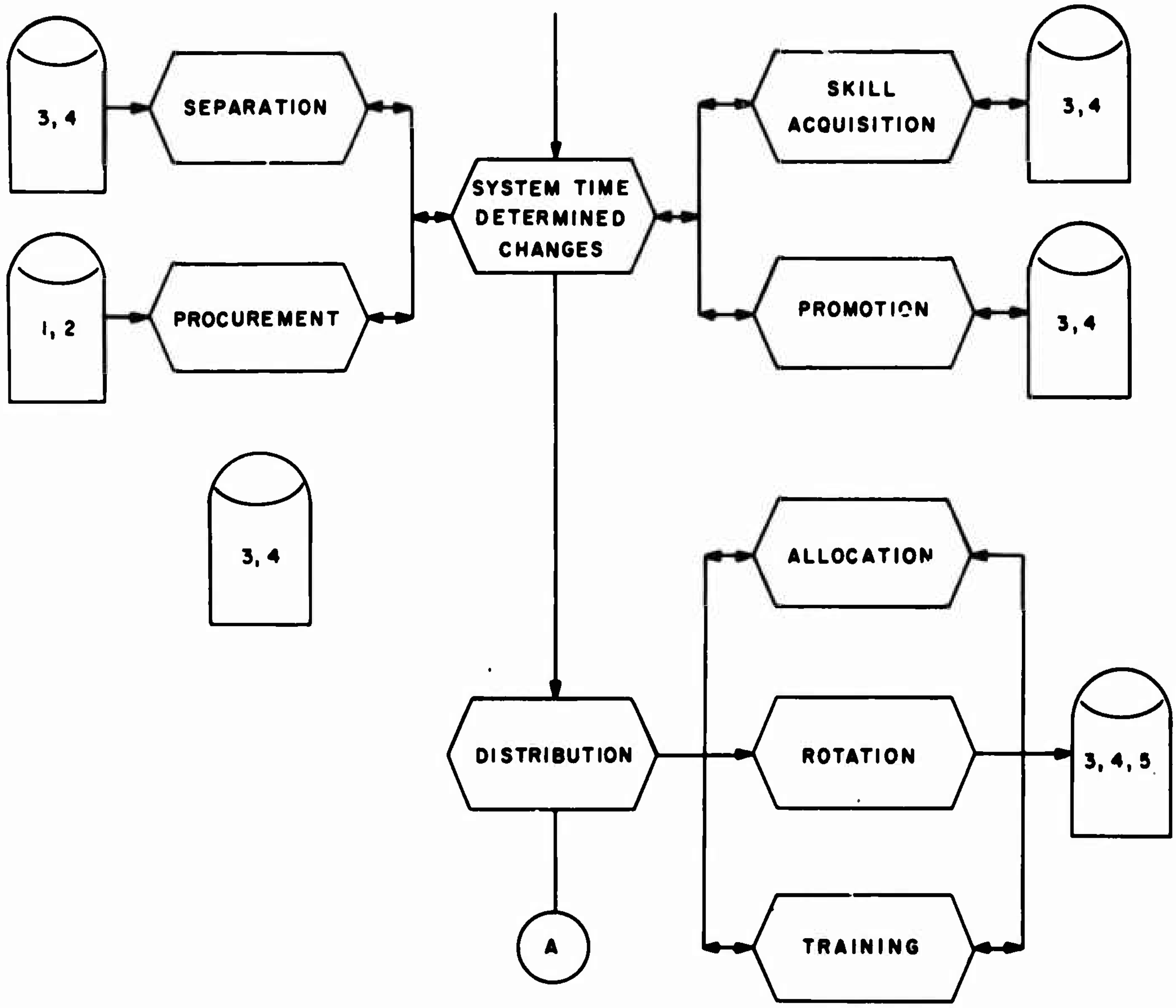


Figure 18 (continued)

Input Required

As might be expected, model definition input for the GES is detailed and extensive. The more complex the system being modeled, the more nodes are required to describe the system. Each node requires several hundred data words to describe it. However, once a basic description is obtained, changes are relatively easy; different policy alternatives may therefore be tried with little additional work. See Figure 19 for the steps in using a simulation model.

In addition to the node description, the GES requires a file of entities as a data base. These may be in any machinable form. The GES system file-building routines are flexible enough to accept most formats, and data may be in integer, decimal, or alphabetic mode.

Output

Two types of output are provided in the GES system. The first is a periodic status report which has four optional reports under control of the analyst. The form of the report and its frequency are also flexible. The second type of report is produced at the end of a simulation run. It provides summary statistics on selected variables and may be used when comparing two or more simulation runs.

Expected Applications of GES

The first application of the GES will be to model the Army Aviator Postgraduate Training System in an attempt to predict with improved accuracy the training necessary to meet a given variety of contingencies. Additional applications are expected from the Officer Branches to study career management problems and to project system status, given estimated promotion, accession and separation policies (expressed as parameters). It is expected that an entity model will also be appropriate for studying the Army ADP personnel system or any other constrained subsystem involving interactions among many variables.

AVIATOR APPLICATION OF THE GENERAL ENTITY SIMULATOR (GES)

Knowledge of and efficient control of the Army aviator personnel system is crucial to effective overall manpower management and to the performance of an important weapon system, cost effectiveness of the system is sensitive to a number of factors. High training cost per capital are characteristic of this system. However, too much emphasis on minimizing the number trained could be disastrous since the rate of aviator buildup in time of crisis is restricted by reason of the extensive initial entry training course of eight months and, the necessity for rapidly deploying aviators when combat contingencies arise.

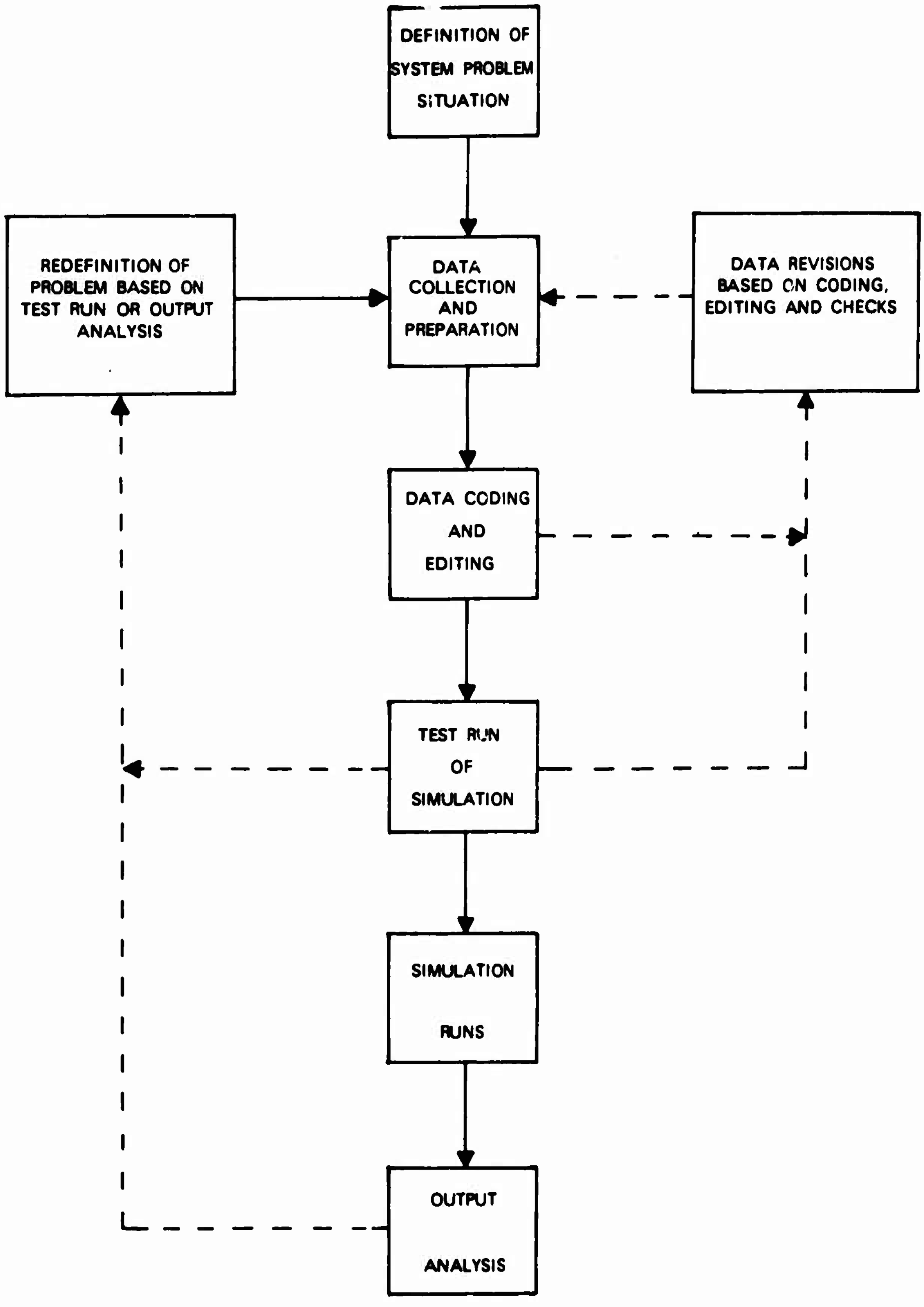


Figure 19. Steps in using a simulation model

To compound the problems provided by the factors mentioned, efficient management of aviator resources is difficult because of the general complexity of the aviator system. Each new aircraft introduced usually requires two new training courses--one to teach a pilot to fly the new aircraft and one to train instructor pilots for the aircraft. An aviator is eligible to enter many training courses and, after acquiring many aircraft skills, he may be placed in one of many different jobs. It can easily be seen that aviator manpower management is faced with extremely complex allocation and planning decisions.

In 1967, the Deputy Secretary of Defense requested that all services develop "computer models for forecasting the specific kinds and amounts of pilot training necessary for various levels of force deployment and tour policies." The directive specified that these models be compatible among the services and that they improve the planning tools available for aviator management. More specifically, BESRL has been asked to forecast Army aviator requirements for:

1. the two initial entry training courses (fixed- and rotary-wing)

2. formal courses: transition, instrument, flight examiner, and safety training

3. a supplement force for contingency conditions

Two SIMPO-I mass flow models, DYNAMOD and the Career-Noncareer Model, have been used extensively in evaluating policy effects on requirements for entry level aviators. It has been possible to make gross estimates about the total number of aviators necessary to support various rotation policies or about the duration of the rotation cycle resulting from specified assignment policies. However, an entity simulation model is regarded as the most appropriate research tool for manipulating the many system variables in order to make meaningful predictions about requirements for training in the numerous specialties within the overall aviator system. Entity simulation is also required to structure the necessary supplement force to be prepared for contingency conditions.

The General Entity Simulator (GES) is being adapted to simulate the graduate training system. An extract of the Officer Master Tape Record will be used as the entity data file from which the GES builds the initial file for the model. Subsequent input to the simulation will be generated by methods developed especially for the SIMPO models.

System definition variables and parameters being used in the model include:

1. Training courses and their prerequisites

2. Number and type of tour areas

3. Job categories and their prerequisites

4. Length of courses

5. Maximum and minimum tour lengths

6. Reenlistment, retirement, and casualty loss rates

7. Promotion rates

8. Time period when training courses begin

9. Method for calculation of instructors based on number of students

10. Number of personnel required in each job category for each time period of the simulation as seen by planners

11. Unplanned changes in requirements

Besides the starting data inventory, the GES will require detailed pilot requirement information for each contingency considered. Preliminary simulations will be made using requirement information which approximates the structure of forces under the contingency considered. Such approximations will be made subjectively by SIMPO aviator system management personnel. Current plans call for the development of computer-aided techniques for speedily generating consistent force structures reflecting specified policies and contingencies as input to SIMPO simulations of the aviator system.

LITERATURE CITED

1. Witt, Joanne and Adele F. Narva. The Dynamic Army Model (DYNAMOD). BESRL Technical Research Report . (in preparation)

2. Olson, Pauline T. ACCMOD: A SIMPO-I dynamic flow model to project enlisted accession needs. BESRL Research Study 68-2. April 1968.

3. Olson, Pauline T. DYROM II: SIMPO-I model representing Army upper enlisted grades. BESRL Research Study 69-2. February 1969. (in press)

4. Niehl, Elizabeth and Richard C. Sorenson. SIMPO-I entity model for determining the qualitative impact of personnel policies. BESRL Technical Research Note 193. January 1968. (AD 831 268)

5. Boldt, Robert F. A multivariate function useful in personnel management models. Proceedings of the U. S. Army Operations Research Symposium 1962.

6. Sorenson, Richard C. Optimal allocation of enlisted men--full regression equation vs aptitude area scores. BESRL Technical Research Note 163. November 1965. (AD 625 224)

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13. ABSTRACT

In response to an operations research requirement established under the sponship of the SIMPO-I Monitor Committee, the Statistical Research and Analysis Division, BESRL has been engaged in study and evaluation of the Army's personnel subsystem with respect to effectiveness of its policies in assignment, training, utilization, and contingency readiness of specialized personnel. The SIMPO-I effort has been directed to development of a model simulation package for assessing quantitatively the cumulative impact of personnel policy changes on the allocation, distribution, and utilization of Army personnel with special attention to effects of policies on deployability.

The present publication reports on progress in the production and planning of computerized models for use in dealing with the manpower system problems noted above and for evaluating alternative personnel policies. The models completed are: DYNAMOD, four mass-flow models representing characteristics of the Army's rotation system; ACCMOD, a dynamic mass flow model of the noncareer enlisted subsystem; DYROM II, a dynamic mass flow model of the upper five enlisted grades, the Career-Noncareer Model, incorporating desirable features of the three preceding models and providing a greater number of options; and the SIMPO-I Quality Input Model, in which simulation is by flow of entities rather than by bulk. Models in final stages of development are: SIMPO-I GMM (General Matrix Manipulator) with capability of simulating many segments of the personnel subsystem; DISTRO, a specific application of the GMM for estimating manpower capabilities under policy constrained deployment; SIMPO-I GES (General Entity Simulator); and the Aviator Entity Flow Model. Part I of the report contains a discussion of the general concepts of the models and their use in policy evaluation. Descriptions of the several models and their application to assignment/rotation problems are given in Part II.

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*Computer technology						
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*Manpower flow patterns						
*Manpower models						
*Computerized models						
*Modeling techniques						
Entity subroutines						
Capabilities analysis						
Personnel--allocation, distribution, utilization						
Statistical methodology						
Simulation tools; techniques						
Nodes						
*Deployability						
*Personnel policy evaluation						

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