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ENLISTED PERSONNEL ALLOCATION SYSTEM
Final Annual Report (6th Year)
October 1986-September 1987
Volume I & Volume II - Appendixes

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The Army Research Institute, with the assistance of the General Research Corporation, is undertaking a project to modernize and improve the way the Army selects individuals for training in Military Occupational Specialties (MOS). This project is called the Development of the Enlisted Personnel Allocation System (EPAS). This report presents the final annual report of activities supporting the development and implementation of EPAS during the 6th year of the contract.

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FOREWORD

The U.S. Army Research Institute for the Behavioral and Social Sciences (ARI) is undertaking a comprehensive research program designed to improve the selection, classification, and allocation of Army personnel. A key part of this program is the Enlisted Personnel Allocation System (EPAS). EPAS will improve personnel performance by achieving a better match between the Army's requirements and the capabilities of the people applying for service.

This report is the Annual Progress Report covering the period of October 1986 through September 1987. It presents an overview of the current prototype version of EPAS. Appendix A presents a summary of the analysis that led to this formulation. Appendix B contains a detailed functional analysis of the current EPAS.

Cont'd

ENLISTED PERSONNEL ALLOCATION SYSTEM: FINAL ANNUAL REPORT (6TH YEAR)

EXECUTIVE SUMMARY

Requirement:

The Army's present person-job match (PJM) system can be improved substantially by assigning more enlistees to jobs that maximize performance and minimize attrition and holding open selected jobs that attract high-quality applicants. These improvements can be realized if administrators look ahead at the supply of applicants and the job training requirements.

Procedure:

The authors are developing a prototype decision support system (DSS), the Enlisted Personnel Allocation System (EPAS) that uses forecasting and large-scale linear optimization to improve the Army's person-job match capabilities. Because of the complexity of this effort, the authors first developed a reduced-scale prototype to evaluate their systems design. The prototype was transferred to the National Institute of Health (NIH) computer facility for more extensive testing and is being enhanced to include features based on continuing research and analysis of the PJM process.

Findings:

The prototype system validated the EPAS design concept. The prototype demonstrated the feasibility of using this complex DSS to guide Army guidance counselors' classification decisions and to evaluate recruiting strategies. Refinement and testing of EPAS at the NIH computer facility has further demonstrated EPAS' capabilities. The EPAS concept represents a significant improvement over current person-job match systems.

Utilization of Findings:

The work justifies continued EPAS research and development. Experiments should be conducted on current recruiting data for refinement of EPAS's capabilities and assessment of policy alternatives. Plans for porting the EPAS onto an Army computer system for further analysis should proceed.

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ENLISTED PERSONNEL ALLOCATION SYSTEM: FINAL ANNUAL REPORT (6TH YEAR)

I. INTRODUCTION

The Army Research Institute (ARI) is sponsoring a major research effort to improve "the selection, classification, and utilization of Army enlisted personnel." The underlying approach associated with the required research has been divided into two major projects:

Project A -- the development and validation of improved selection and classification instruments and standards.

Project B -- development of a prototype computerized personnel allocation system.

The second of these projects, Project B, was awarded to the General Research Corporation (GRC) in September of 1982. The major objective of Project B is to

> "...develop a prototype system to link personnel resources to Army requirements in ways which will optimize the total effectiveness of the Army. This research should yield a set of operational, computer-assisted decision aids for military personnel actions.... The research will build on the state-of-the-art in such areas as: differential classification of people/jobs, prediction of employee work behavior, optimization, algorithms, methods of combining multiple objectives, and estimation of utility or pay-off equations as used in (or planned for) the Air Force preenlistment, person-job match system.
> (Statement of Work, pg. 2)

GRC has developed the Enlisted Personnel Allocation System (EPAS) to meet the requirements of the contract.

STATEMENT OF PROBLEM

The Army routinely processes approximately 140,000 non-prior service (NPS) applicants each year. In theory, each of these applicants could be eligible for approximately 6,000 MOS/training start dates, resulting in some 840 million possible combinations. Army policy requires that the Military Occupational Specialty (MOS) in which each new recruit is to be trained be determined at time of enlistment. The applicant/MOS classifications made at this time have significant impact in such areas as

- Recruiting effectiveness
- Force readiness
- Soldier performance
- Retainability

Making these classification decisions effectively and efficiently requires an understanding of the relationship of an individual's characteristics to probable performance in the Army in some specific MOS. This, in turn, requires both the ability to quantify this relationship and the means to systematically apply this knowledge. There is an ever-present need to improve and extend both the validity and the effectiveness of the Army's classification process.

In the current Army process, volunteers take the Armed Services Vocational Aptitude Battery (ASVAB). This test produces scores that are used to determine if the applicant meets the minimum eligibility for MOS. The Army's current classification methodology, part of the REQUEST system, uses these test scores to eliminate MOS for which the applicant is not qualified. The remaining MOS are then processed to generate an ordered list of jobs which the Army would like the applicant to consider. This process, details of which are described in Appendix A, places primary emphasis on the need to fill vacant training seats within the time window being examined; virtually no emphasis is placed on predicting the applicant's performance in the MOS being considered.

This current process does not "look ahead" in any significant manner to consider future impacts or alternatives. It can not, therefore, address personnel factors such as

(a) What is the effect of filling a training seat with a minimally qualified volunteer?

(b) What is the impact of deliberately leaving a training seat empty?

(c) What is the probability that a person who is "better" qualified than the current applicant will become available to fill some specific training seat?

(d) What contribution will some specific person-job match make to the applicant's performance in the initial entry skill?

It is important to note the sequential nature of the current process. The Army must consider volunteers in the order in which they arrive for processing. It is unrealistic to assume some system will control the actual arrival sequence of applicants.

Instead, the design criterion of this contract specifies the design and validation of a system concept which can be used to "optimally" make the decision about which MOS the Army would like applicants to serve in. The guidance provided by such a system would represent a changing definition based on real-time assessments of training requirements and anticipated applicant arrivals. Use of this system would place applicants where they can be expected to perform to their maximum potential, within the policy restrictions and mission requirements of the Army.

ORGANIZATION OF REPORT

GRC has conducted extensive research and analysis to determine the best technique for the development of a system concept to implement the desired optimization capabilities. Based on this research, a prototype system was designed and developed to evaluate alternative performance predictors and classification techniques.

This report documents GRC's research pursuant to this contract effort. The report contains the following sections:

- I A general introduction to the report.
- II An overview of the approach used by GRC in the development of the prototype computerized allocation system, EPAS.
- III A discussion of EPAS's capabilities to support management/policy analysis.
- IV A discussion of EPAS's capabilities to provide support to the classification and assignment process.
- V A discussion of EPAS's operation.
- VI An overview of progress since the last reporting period.

In addition, four appendixes are provided to complement the information contained within this report. The appendixes are as follows:

- A An overview of the background leading to the current formulation of EPAS.
- B A detailed functional description of EPAS.
- C References
- D The master plan for the remainder of the contract.

II. OVERVIEW OF APPROACH

The initial contract objective was to investigate techniques for, and create a prototype of, a system supporting real-time enlisted personnel classification (as performed by the REQUEST system), while providing the ability to utilize new predictors of performance being developed by Project A. Functional analysis conducted as part of the research, however, showed that a planning capability was needed to provide for the analysis of policy alternatives and determination of optimum strategies for the classification and allocation of recruits. GRC anticipates that this capability, unique to EPAS, will provide the Army with a powerful management tool.

The policy analysis capability inherent to EPAS allows Army analysts and managers to simulate the flow of applicants through the allocation process. Input to real-time classifications flows directly from this planning subsystem, i.e., the developed strategies could then be used to provide guidance to the REQUEST system. Figure 1 depicts the EPAS functions required to support classification capabilities. Each of the major activities is summarized below.

SUPPORT ACCESSION PLAN/PROGRAM DEVELOPMENT

Non-Prior Service Processing

Virtually all the EPAS research and development has been in the non-prior service area. The results of this work are the fundamental methodologies and system capabilities which have been implemented for policy analysis.

The Project B contract states: "...strategies are needed for optimally allocating individuals on a one-by-one basis while simultaneously taking into account the overall goals and missions of the Army..." Analyses were conducted to determine the functions necessary to support the allocation of non-prior service (NPS) personnel. These analyses indicated that the use of a large-scale, linear optimization methodology for allocation of non-prior service personnel was feasible. Linear optimization provides the ability to match the anticipated applicant supply of applicants to the known training requirements so as to maximize the overall performance of the applicants while meeting the Army's requirements.

The principal functional areas required to provide the non-prior service processing capability were then identified. These areas, depicted in Figure 2, are:

(1) Define Applicant Supply -- predicting the future supply of applicants in sufficient detail to allow the model to accurately predict performance in selected MOS.

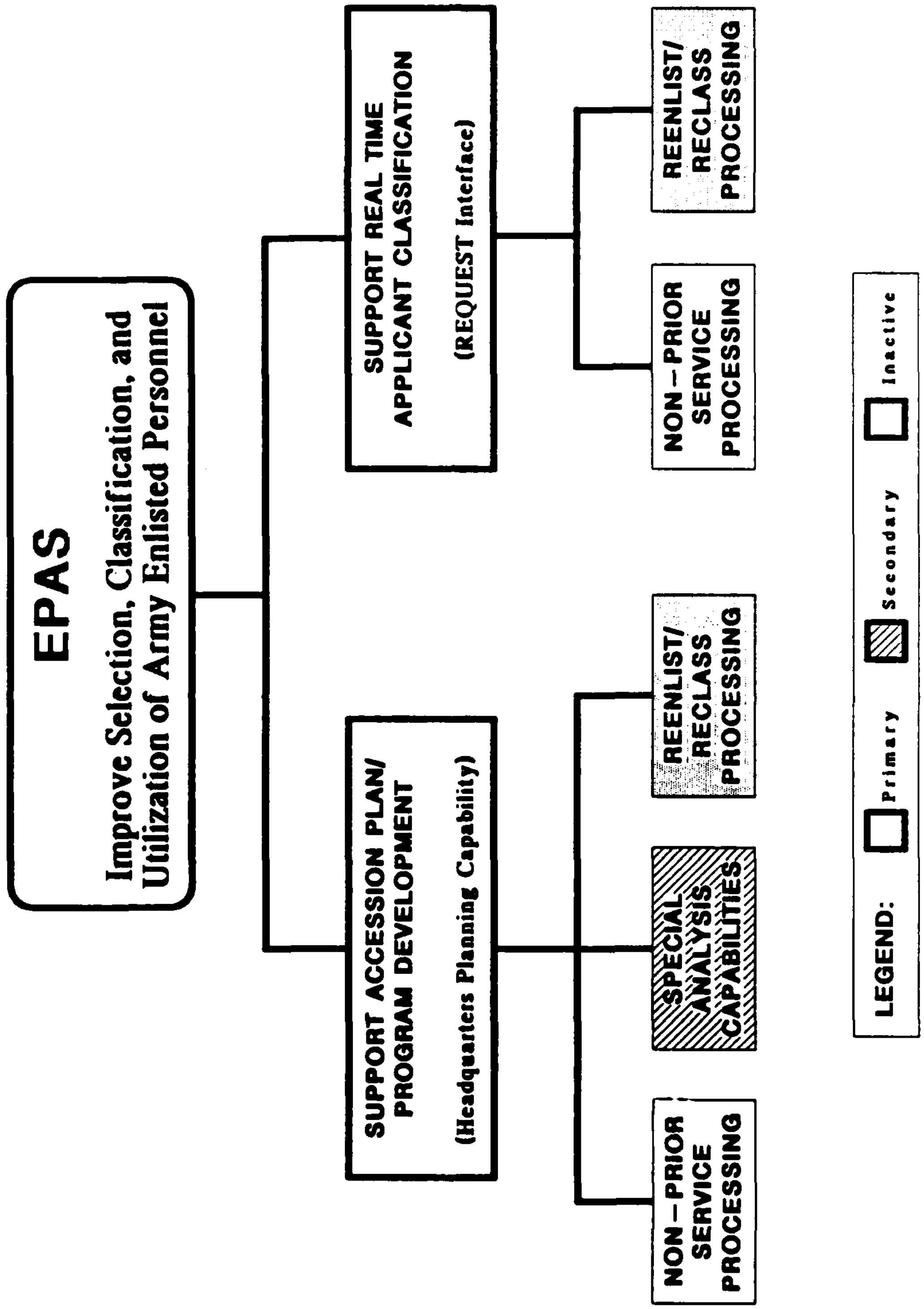

Figure 1. EPAS Functional Areas

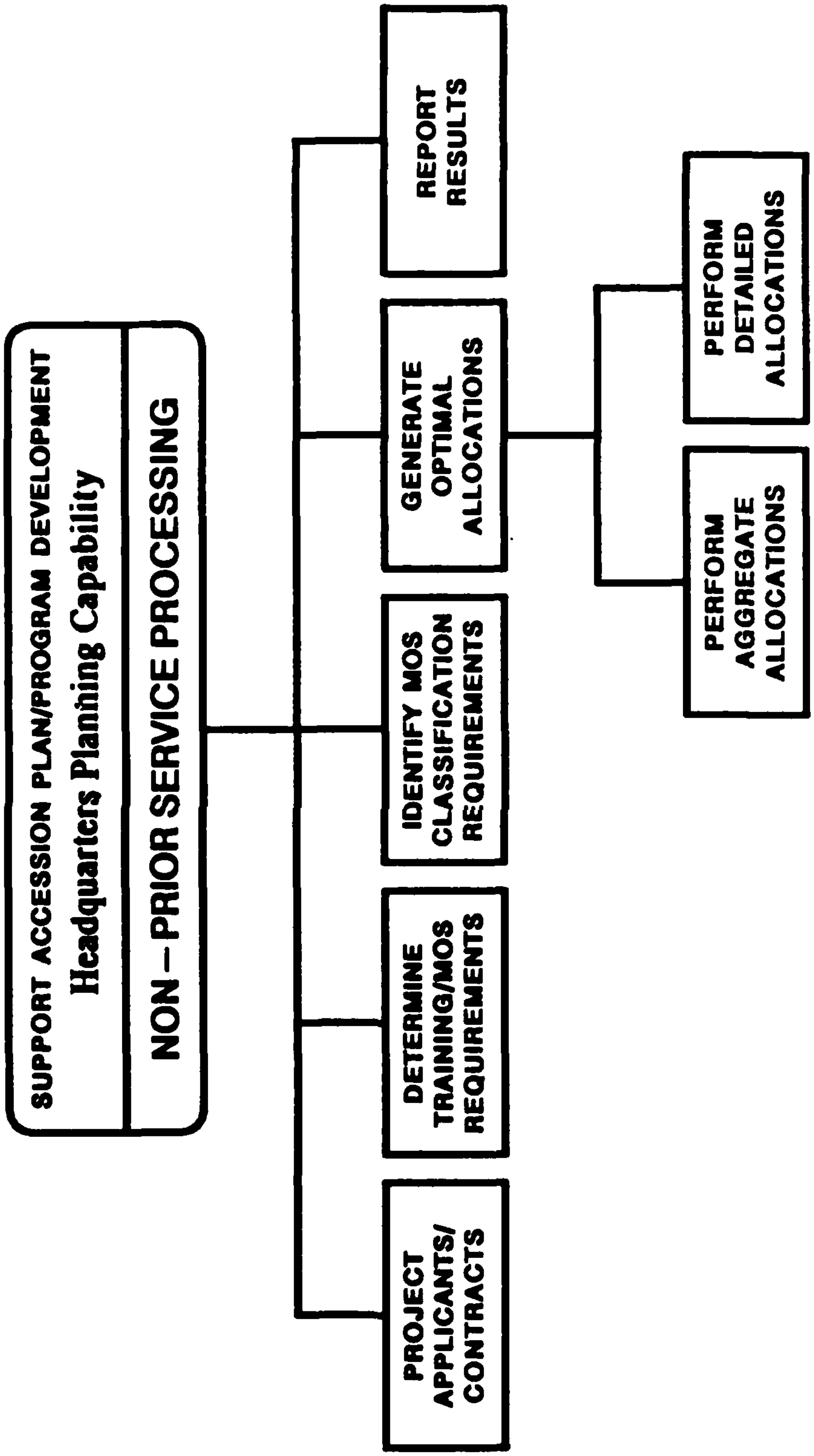

Figure 2. Functional Areas in EPAS Approach

(2) Define MOS Requirements -- defining both the future MOS training requirements and restrictions governing applicant eligibility for individual MOS.

(3) Develop Optimization Model -- formulate an optimization model which generates an optimal, feasible distribution of applicants to MOS, while insuring that Army policy guidance and requirements are met.

(4) Generate Individual Classfication Recommendations -- develop case-by-case MOS recommendations ensuring that the results from the optimization model, individual capabilities, Army requirements, and up-to-the-minute status of classes are all considered.

A discussion of the design of the Headquarters Planning concept is provided in Section III.

Special Analysis Capabilities

Through a continuing functional analysis, GRC analysts have identified several capabilities that would be desirable in the planning subsystem. These capabilities are identified as secondary research and development areas as they are not currently included as part of the existing system capabilities. Instead, as resources permit, the capabilities of the Headquarters Planning concept will be expanded to encompass these capabilities. Those identified at this time are:

(1) Accession Mission Analysis. This capability would recommend an optimal set of recruiting missions, given desired performance levels and MOS targets.

(2) Sensitivity Analysis. This capability would determine the qualitative and quantitative impacts of changing MOS requirements based on user-selected objectives.

(3) Training Seat Allocation. This capability would provide a means to assess various training plan options to determine the effect on user-selected performance measures.

(4) Incentive Plan Analysis. This capability would provide a means to assess incentives plans in terms of the feasibility to meet MOS accession targets and user-selected performance measures.

Reenlistment and Reclassification Processing

The purpose of this function is to provide reenlistment and reclassification with capabilities similar to those developed for the non-prior service accession function. A significant difference exists between these functional areas, however, in that aspects of this support are, or planned to be, addressed through the FORECAST Enlisted Systems Project. Furthermore, while data and predictors exist or are being developed (by Project A) for analysis of NPS personnel, no corresponding information exists for reenlistment/reclassification actions. Therefore, no capabilities have been implemented at this time.

SUPPORT REAL-TIME APPLICANT CLASSIFICATION

Non-Prior Service Processing

The Army's REQUEST system currently provides real-time applicant classification, in addition to a variety of other services (e.g., reservation processing) designed to support the recruiting process. The principal issue behind GRC's approach to real-time applicant classification, therefore, has been to determine means for improving applicant performance based on the best available research without adversely impacting the operational environment.

Accordingly, research has focused on two issues:

(1) Communicating optimal guidance from EPAS to REQUEST.

(2) Determining how the REQUEST search algorithms can be modified to utilize the EPAS optimal guidance.

Reenlistment and Reclassification Processing

The purpose of this function is to provide the Army's reenlistment system (RETAIN) with optimal guidance comparable to that provided REQUEST. Initial research into this activity showed that, unlike the accession function, the reenlistment/reclassification functions did not have the explicitly defined objectives necessary for an EPAS-like optimization capability (Midlam and Brown, 1986). For this reason, and because of potential overlap with the research being performed as part of the FORECAST Enlisted Systems Project, this research is not being pursued at this time.

III. EPAS APPROACH
HEADQUARTERS PLANNING CONCEPT

Non-prior service assignment processing to support headquarters planning has been the main research and development area. Candidate methodologies have been investigated for implementing the four functional areas described in Section II. The Enlisted Personnel Allocation System (EPAS) consists of four principal modules, one for each of the four functional areas. These modules, depicted in Figure 3, are:

(1) Quality Forecasting Module (QFM) -- defines applicant supply

(2) Training Requirements Module (TRM) -- defines MOS requirements

(3) Quality Allocation Module (QAM) -- formulates and executes the aggregate optimization model

(4) Applicant Classification Module (ACM) -- generates individual recruit classfication recommendations

In the sections which follow, the processing performed in support of each of the functional requirements is addressed. This includes an overview of the appropriate module, as well as a discussion of significant supporting procedures. Detail on the current prototype implementation may be found in Appendix B.

DEFINE APPLICANT SUPPLY

Combining Similar Applicants

In Section I, it was indicated that there exist approximately 840 million possible combinations of applicants to MOS classes during a given year--a number considerably larger than available computer technology can support. Some means is required, therefore, for reducing the problem to a tractable size. This reduction was accomplished by performing research into means of combining, or clustering, both the applicants and the MOS in groups. (MOS clustering is described in the Define MOS Requirements section, below.)

When clustering applicants, two requirement have to be met:

(1) The system must maintain the ability to enforce Army policy restrictions and guidelines,

(2) The ability to predict an applicant's likely performance in a selected MOS must be maintained.

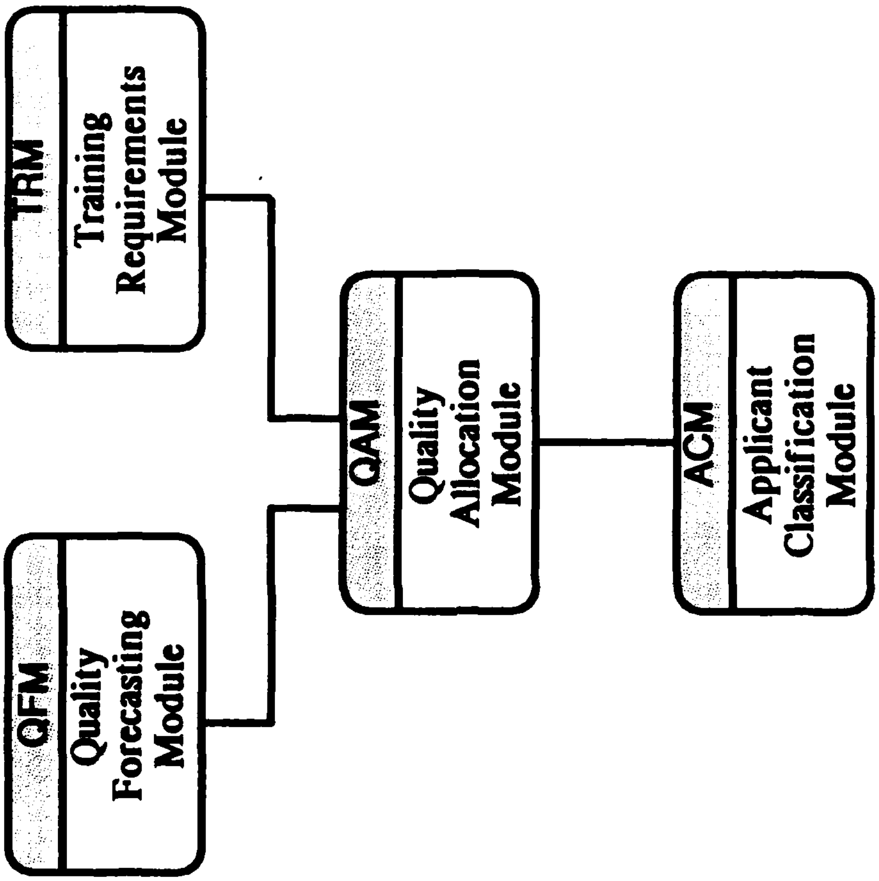

Figure 3. Headquarters Planning Capability — Primary Modules

Key performance predictors (see Appendix A) were identified which enabled the development of combinations of applicants, called Supply Groups, which met both of these requirements. A two-step process is currently used to define EPAS' Supply Groups.

First the contract population is subdivided into distinct subpopulations based on demographic characteristics. The subpopulations allow EPAS to model Army policy, such as Quality Goals. The demographics used to subdivide the population are:

(1) Gender -- male and female.

(2) Education -- three classifications are used for education: High School Graduates, High School Seniors, and Non-Graduates.

(3) Armed Forces Qualifications Test (AFQT) Score -- categories I-IIIA, category IIIB, and category IV.

Next, each of the subpopulations were clustered based on ASVAB Aptitude Area Composite Scores. Project A analysis has demonstrated that the ASVAB test scores are valid predictors of performance (McLaughlin, 1984). A computerized technique, using Ward's Minimum Variance Method (Ward, 1963), was used to generate 81 distinct Supply Groups.

Detailed discussions of the methodology used to develop the Supply Groups and the currently implemented groupings can be found in Appendix A.

Forecasting Contractees

The Army's recruiting process is a sequential, first-come-first-serve process. Linear optimization techniques, on the other hand, distribute a predefined available supply of some product (in this case, NPS applicants) across an established demand for that product (training seats). A forecast of the number, quality and arrival times of contractees was required, therefore, to determine the population to assign to MOS and associated school seats.

A number of techniques are available for forecasting volunteer characteristics and arrival rates. GRC has provided a system which integrates existing methodologies into the EPAS concept, thus providing Army analysts and managers with the ability to evaluate policy alternatives using any of several forecasting techniques. The basic techniques currently in EPAS (which are detailed in Appendix A) are:

(1) Dale-Gilroy (ARI) econometric model
(2) Horne (ARI) econometric model
(3) USAREC mission statements
(4) GRC trend model
(5) GRC econometric model

Regardless of the forecasting technique employed, the projections of applicants must be presented in the form of EPAS Supply Groups to be consistent with the other modules within the system. Therefore, procedures were developed for each of the basic forecasting techniques to redefine the projections into Supply Groups.

DETERMINE MOS REQUIREMENTS

This functional area determines the training constraints (class size, start dates, etc.) and MOS requirements, including quality mission, which are targets for the allocation process. These data are defined externally; e.g., the training constraints are developed by TRADOC and entered into the ATRRS system. Thus, procedures have been developed to allow access to these data. Several other features have been developed to support the Headquarters Planning capabilities of EPAS.

MOS Clustering

As with the Supply Groups discussed above, MOS had to be aggregated into groups, called MOS Clusters, which maintain performance differentiability and the ability to enforce policy restrictions. Details of the methodology and current formulation are found in the Appendixes.

MOS Clustering was performed by first aggregating the MOS into distinct groups based on their characteristics. The basic criteria currently used to define the MOS Clusters, in the order of their priority, are:

(1) Female Exclusions -- some MOS, such as those classified as combat skills, are closed to female recruits. MOS were divided into two groups: male-only and open to all.

(2) Education -- some MOS require a high school education. The two gender-based groups were each divided into two subgroups: MOS requiring a high school education and others.

(3) Qualifying Aptitude Area ASVAB Composite Score -- the minimum ASVAB score which must be achieved to be eligible to serve in the MOS.

(4) DoD Occupational Areas -- each of the subgroups developed above were further subdivided into nine groupings based on the DoD Occupational Areas, shown in Table 1. This criterion, used by the Department of Defense to categorize skill types across all services, groups the skills based on a broad measure of their duties.

This consecutive decomposition process resulted in too many clusters to be effectively used by the model. An expert panel was formed, therefore, to review the clusters and their component MOS and identify

TABLE 1
DoD Occupational Areas

CODE	DoD OCCUPATIONAL AREA
0	Infantry, Gun Crews, Seamanship
1	Electronic Equipment Repair
2	Communications and Intelligence
3	Medical and Dental
4	Other Technical
5	Functional Support and Administrative
6	Electrical/Mechanical Repair
7	Craftsmen
8	Service and Supply

clusters which were similar and could be combined. A total of 58 clusters resulted; additional detail on the current cluster can be found in Appendix A.

Customized Training Plan

To effect policy analyses of changes in the training plan, Army analysts require the ability to create customized training plans. EPAS supports this by providing detailed editors which allow analysts to perform such activities as altering class sizes or start dates, or entering or deleting MOS.

Simulated Fill Capability

When the planning capabilities of EPAS are being employed, the system will automatically update training fill to reflect the simulated assignments being generated by the system. Clearly, this process cannot be allowed to interfere with the actual training plan defined for REQUEST's day-to-day operations. Similarly, if repeated analyses are being conducted on a customized training plan, the Army analyst should not be required to redefine the training plan for each alternative being examined. EPAS, therefore, has been developed to utilize a temporary definition of the selected training plan, thus allowing full simulations without altering the training plan on which the simulations are based.

Identify MOS Classification Requirements

Each MOS has certain eligibility requirements, such as minimum ASVAB scores and gender restrictions. EPAS must include these MOS requirements to prevent the generation of allocation plans which, while feasible in an overall sense, would violate policy guidelines and, therefore, not be practical. This functional requirement has been addressed by the inclusion of procedures to allow definition and management of these criteria. As with other components of the policy analysis capability, customized definitions can be developed to allow evaluation of alternatives (such as altering the minimum eligibility score for selected MOS).

GENERATE OPTIMAL ALLOCATIONS

This functional area addresses the principal requirement of EPAS. Optimization is not feasible for allocating individuals on a one-by-one basis, while sequential classification cannot take into account the overall goals and missions of the Army by "looking ahead" at future applicant supply and MOS requirements. Research was performed to identify and develop techniques by which optimal strategies could be applied to an inherently sequential process.

Perform Aggregate Allocations

A two-stage approach was employed to allow EPAS to "...allocate individuals on a one-by-one basis while simultaneously taking into account the overall goals of the Army..." (SOW, pg. 4). Optimization is used to generate aggregate allocations, thus providing a classification strategy to address the overall goals and missions. The optimization develops a 12-month classification strategy that meets all training targets and constraints defined at the Supply Group and MOS Cluster level of detail.

This classification strategy is then input to a detailed, sequential classification process to process individuals. The resulting sequential process gains "look-ahead" intelligence of future recruiting conditions when making classification recommendations.

Based on the analyses described in Appendix A, GRC analysts developed a modified assignment network, using special structure techniques to incorporate various Army recruiting policies. Development of this network model is complete and comprises the principle optimization methodology in EPAS.

Formulation of the Network Model

Figure 4 depicts the basic formulation used by the EPAS network model. (An in-depth discussion of the current network formulation used is found in Appendix B.) The network model works as follows:

(1) Forecasted supply for each Supply Group, by month, is input to the model. This supply may be used to fill training requirements, specified by MOS Cluster, for any month from the supply's arrival month to some prespecified number of months into the future. This future fill ability simulates the Army's Delayed Entry Program (DEP) and provides the model with its ability to balance the recruit allocations to optimally meet the Army's goals.

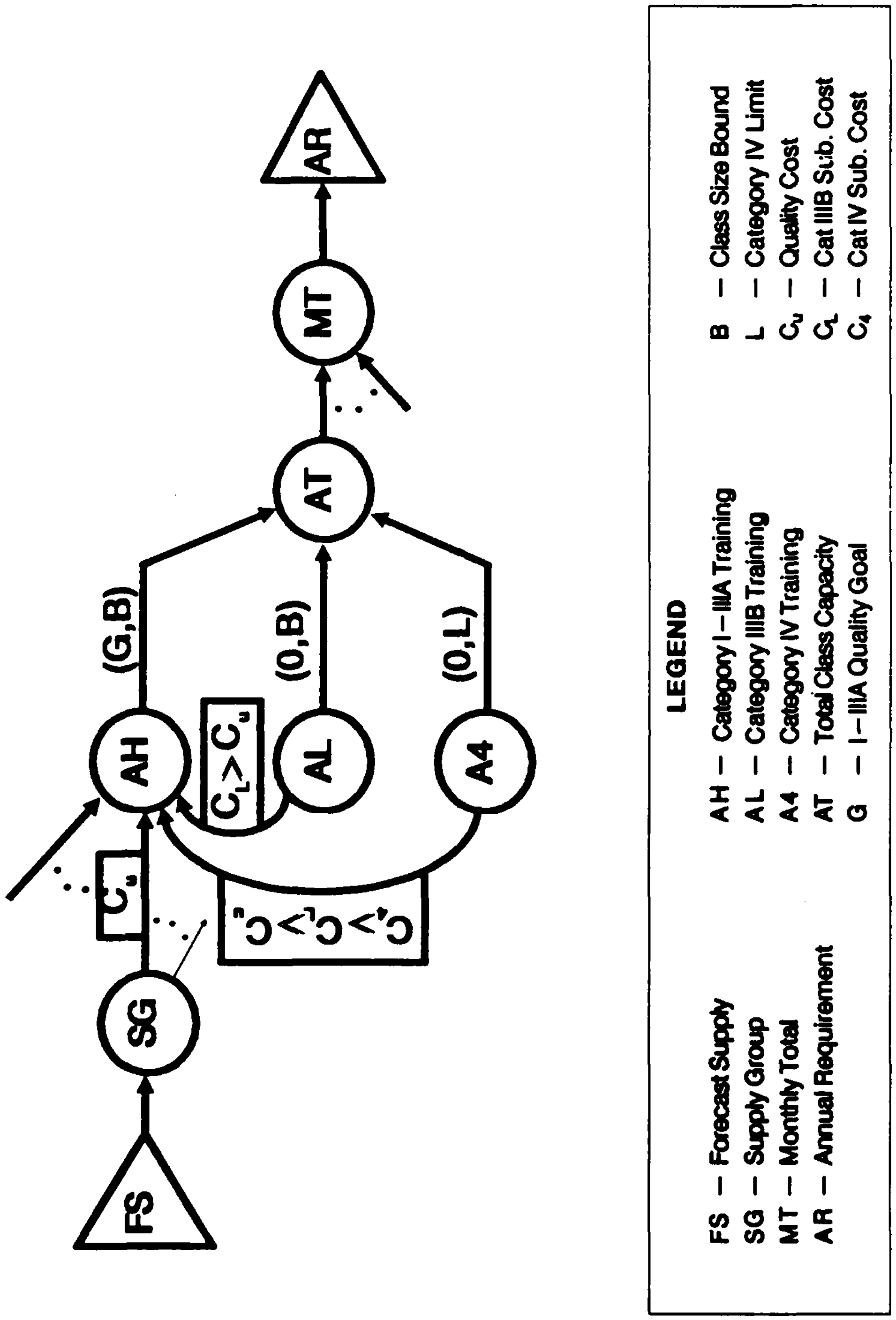

Figure 4. EPAS Network Formulation

(2) Each MOS Cluster has its specific training parameters defined:

(a) The quality goal, i.e., what portion of the population should be filled by AFQT Category I-IIIA recruits. The model will assign each MOS at least this number of quality applicants, if this is feasible.

(b) The limit on AFQT Category IV personnel, i.e., the maximum number of such personnel which will be allowed into an MOS Cluster.

(c) The upper bound on the training capacity. The total training capacity of each MOS cluster, in general, exceeds the annual training demand for that cluster. The model utilizes this fact to provide additional flexibility in the distribution of its supply; each class will, however, not exceed its maximum capacity.

(d) The annual training requirement. This value provides the desired goal, i.e., the total number of personnel to be trained for an MOS Cluster during the year.

(3) The "cost" associated with each possible Supply Group/MOS Cluster combination is generated by an ancillary procedure (the Metric Generation Module). The network algorithm utilizes these costs to determine the optimal configuration, within the imposed limits. The term "cost" is an operations research term which does not necessarily refer to dollar cost. It is, instead, some measure of performance to be used by the model. Examples of performance costs available are:

(a) First Term Attrition -- personnel are allocated to MOS so as to minimize their loss prior to completing the first term of enlistment.

(b) ASVAB Composite Score -- personnel are allocated to MOS so as to maximize the average Aptitude Area scores for all initial entry skills.

(c) DEP/Attrition Cost -- personnel are allocated to MOS so as to minimize the dollar cost associated with a combination of time in the DEP and first term attrition.

When the optimal solution has been generated, the resulting guidance is formulated so that it can be communicated to the detailed, sequential allocation procedures. (Appendix B provides a detailed explanation of the network formulation and of the ancillary procedures required to generate the optimal solution and, subsequently, the ordered lists.)

The network formulation provides rapid, optimal, time-phased allocations incorporating annual MOS training requirements and quality goals. When this guidance is communicated to the detailed allocation procedure, it allows generation of ordered lists of recommended MOS assignments which will meet the immediate needs of the Army, address the long-range objectives of the Army, and incorporate the predicted performance of the individual applicant.

Model Formulation Summary

The three functional areas described thus far -- define applicant supply, define MOS requirements, formulation of the optimization model -- comprise the "core" of EPAS. This core provides a stand-alone, analysis capability enabling the Army analyst to examine feasibility and impact of policy alternatives at an aggregate level.

GENERATE INDIVIDUAL CLASSIFICATION RECOMMENDATIONS

The optimization model leads to aggregate allocations which do not include all the detail necessary to make individual sequential MOS recommendations. The capability had to be developed, therefore, for dealing with the contract's requirement to allocate "individuals on a one-by-one basis." Personal choice, specific individual characteristics, and hour-by-hour MOS availability all contribute to a level of detail with which the optimization procedures cannot deal.

A detailed, sequential classification routine, called the Applicant Classification Module (ACM), was developed to simulate the classification of individual recruits, taking into account the individual characteristics which may allow or prevent specific MOS assignments. Similarly, the ACM can evaluate each MOS training class (rather than MOS Clusters) to ensure the availability of the MOS for the applicant.

The ACM, as depicted in Figure 5, has a series of modules designed to capture some specific aspect of the person-job match being examined. The modular design allows EPAS to respond to new measures; for example, if the Project A analyses develop a new measure for predicting job performance, it could easily be included in the system by defining a new module incorporating the results of their analyses. These modules deal with categorizations of issues, specifically:

(1) Army Requirements. These modules reflect the need for the Army to meet its annual mission independent of the characteristics of the individual applicants. This allows Army managers to ensure that less desirable, hard-to-fill skills are given additional emphasis by the system so that their annual requirements are met.

(2) Applicant Characteristics. These modules reflect the anticipated performance of the applicant, allowing the system to determine the MOS in which the applicant can perform best. This MOS is called the "local optimal" as it reflects the individual's best job match, without regard to the overall goals and missions of the Army.

(3) Optimization Ordered List. This is the module which provides the ACM with the ability to identify the "global optimal," i.e., the best job match taking into account the overall goals and missions of the Army.

Each module measures some specific characteristic of the person-job match, e.g., the predicted first term attrition. Each of the disparate measures are scaled to a common, dimensionless unit measure and are then linearly weighted. The resulting composite measure provides a numeric payoff for each specific person-job match. The job match with the highest numerical value represents the "best" possible assignment, taking into consideration the individual's characteristics, the Army's requirements, and the long-range goals and missions.

By combining the optimization routine's aggregate guidance with the ACM's detailed allocations, EPAS can perform accurate simulations of the probable impacts of policy alternatives. (Additional detail on this simulation capability can be found in Section V, the EPAS System's Context, and Appendix B.)

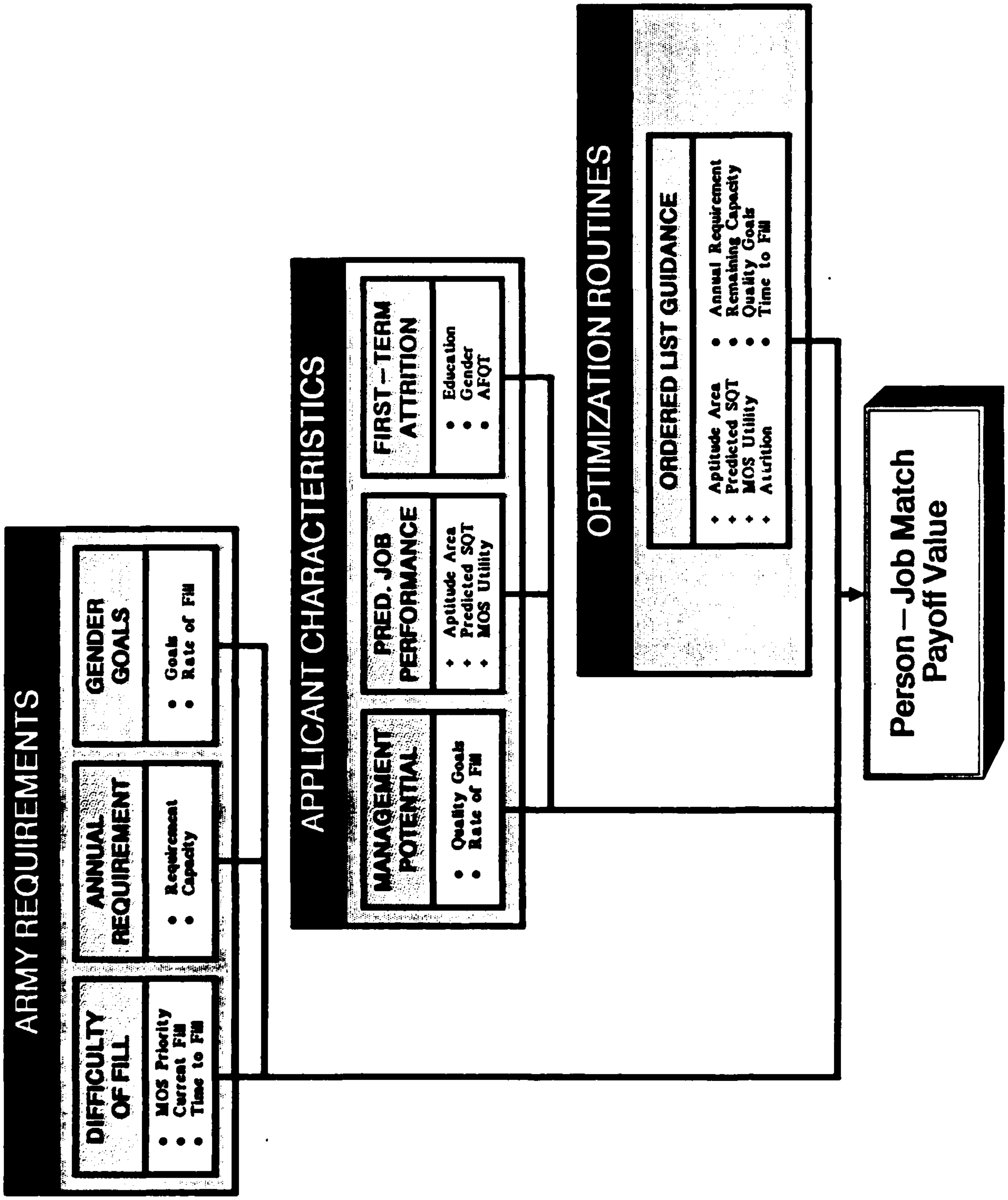

Figure 5. Detailed Allocation Structure

IV. EPAS APPROACH
REAL-TIME APPLICANT CLASSIFICATION

The long-range objective of this research is the design of a computerized decision support system which will apply Project A's new measures and Project B's new techniques to the actual selection and classification of recruits. This objective is still in the research phase.

The Army's current classification system is a subsystem within the REQUEST system. This classification system linearly weights a number of factors to generate an ordered list of recommended jobs. (See discussion in Appendix A for additional details.) Two major modifications are required if REQUEST is to be able to apply the lessons learned from Projects A and B.

(1) New factors will have to be added to, or existing factors replaced in, the current hierarchy to utilize the Project A measures of prediction.

(2) A means must be developed to utilize the planning guidance from the EPAS (Project B) optimization routine.

Research has shown that a synergistic relationship exists between the two projects. The results of either project may be used independently to provide performance improvements over the current system. Using both together, however, provides an anticipated improvement greater than the sum of the two used independently.

Figure 6 graphically depicts predicted performance increases in AFQT Category I-IIIA equivalents.[1] One of the early results from the Project A research was a recommendation to redefine the ASVAB subtests used to compute the Mechanical Maintenance (MM) aptitude area composite score. As can be seen in the figure, application of this independently resulted in a slight gain of performance, equivalent to about 1,000 additional AFQT Category I-IIIA personnel. Similarly, independent use of EPAS resulted in an increase of nearly 30,000 I-IIIA equivalents.

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1 AFQT Category I-IIIA equivalents refers to the number of additional quality (i.e., AFQT Category I-IIIA) personnel who would have to be recruited to achieve the same performance increase as was gained by redistributing the personnel actually recruited. The USAREC recruiting budget is directly affected by the number of quality recruits required; thus, this measure depicts dollar savings as well a performance improvements.

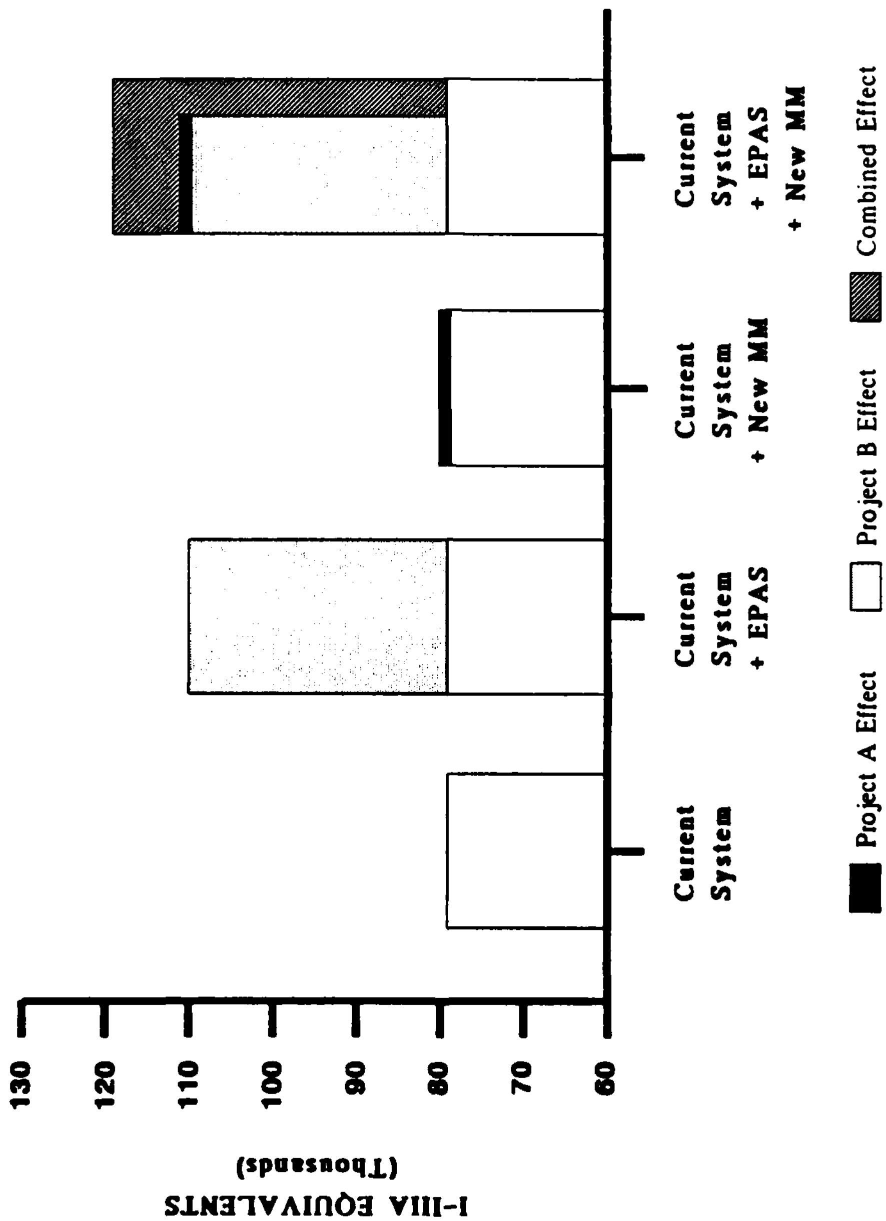

Figure 6. Project A and B Synergistic Effects

When the two are used together a substantial increase, equivalent to approximately 40,000 additional I-IIIA personnel, was experienced. This increase is significantly more than the simple sum of the two efforts taken independently.

These results clearly indicate the necessity of developing the means of implementing both the optimal guidance from EPAS and the new performance predictors being developed by Project A. Research into the recommended means of providing EPAS' optimal guidance to REQUEST is discussed in Appendix A. Implementing optimal guidance has two components:

(1) The generation of the guidance, specifically, how will this process differ from the optimal guidance being generated for the Headquarters Planning concept.

(2) The development of an interface between EPAS and REQUEST so the optimal guidance can be communicated to, and utilized by, REQUEST for its detailed classification and allocation functions.

GENERATING EPAS GUIDANCE

The functional requirements, depicted in Figure 7, associated with generating guidance to REQUEST closely parallel those for generating aggregate assignments for the headquarters planning capability. The methodology employed to perform this function will be identical to that described in the network formulation of the optimization routines. [The ACM, which provides a detailed simulation capability, will not be used.]

The principal distinction between the planning capability and the potential real-time classification network optimization routines would be in the data used. In the real-time environment, all requisite data, e.g., applicant information, school seat information, MOS requirements, would be defined within operational systems. Since support of real-time classification must utilize the policies and restrictions currently in effect, EPAS would have to be able to access actual data instead of using the temporary, customized files found in the planning system. Supporting this functional requirement will necessitate accessing systems other than EPAS and REQUEST, e.g., ATRRS.

A second difference between real-time classification and planning is the need to provide transaction-oriented update capability. The planning capability, since it is using artificial data, updates its temporary files as part of its standard processing. The real-time classification routines, however, must respond to the actual transactions recorded during REQUEST's daily operations.

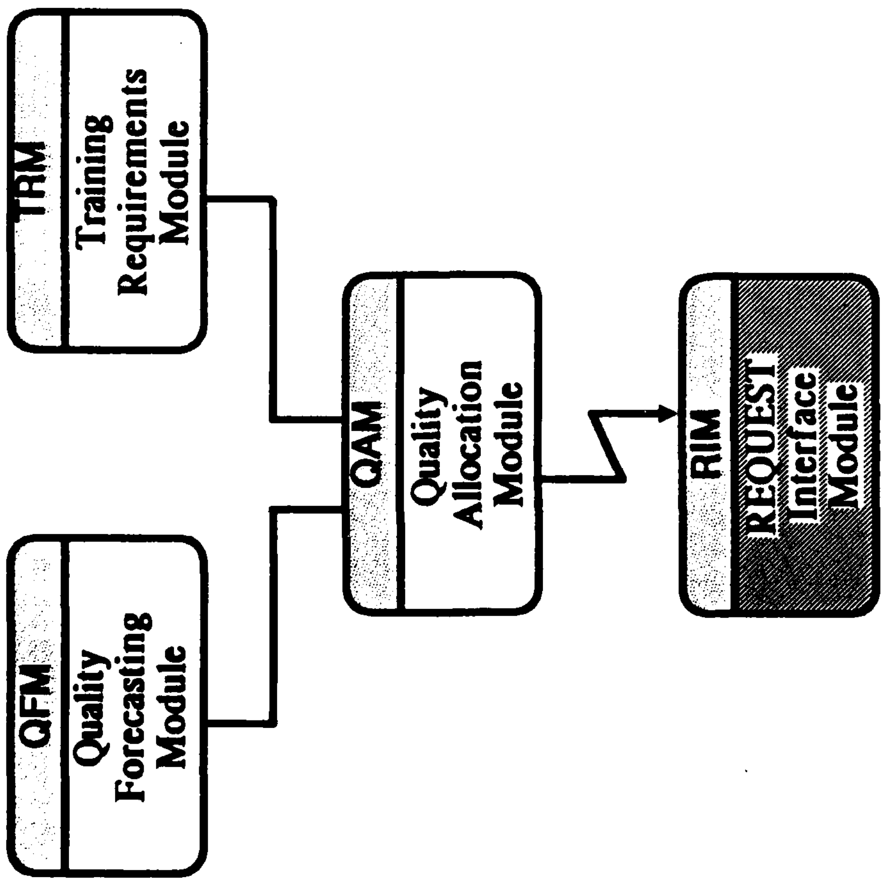

Figure 7. EPAS Real-Time Classification

Investigations continue into the best means for accessing both the operational data and REQUEST transactions so as to develop efficient means of communicating between the multiple systems involved in supporting real-time classification.

INTERFACE WITH REQUEST

The interface between EPAS and REQUEST is a critical requirement. The feasibility of using optimization techniques to improve classification of NPS recruits has been successfully demonstrated; the vehicle -- the ordered list -- by which the optimal solution may be communicated in a usable fashion to a sequential allocation process has been developed. If the results of this research are to be applied in a real-time setting, two considerations must be addressed:

(1) REQUEST must be modified in a manner which will allow it to utilize the EPAS guidance.

(2) REQUEST must be able to accept new performance predictors as developed by Project A.

Utilizing EPAS Guidance

Because of the large number of MOS/start date combinations available to applicants, both EPAS and the REQUEST search routine utilize logic to reduce the number of combinations to actually be considered for an applicant. Both systems first eliminate all MOS for which the applicant is not eligible, e.g., those for which the applicant fails to achieve the minimum qualifying ASVAB score.

In EPAS, further reduction is based on the ordered list generated by the optimization routines. The ordered list has the effect of eliminating MOS which, while the applicant meets eligibility requirements, represent less desirable assignments while examining classes for the remaining MOS throughout the DEP horizon.

REQUEST's search algorithm, on the other hand, only examines those MOS with classes within a specified, limited time horizon, i.e., some number of weeks (e.g., five weeks) from a specified date of availability. This has the affect both of eliminating MOS for which the applicant is qualified and curtailing the number of classes for an eligible MOS.

Accept New Predictors

The focus of the Project A effort is to develop new performance predictors, enabling the Army to better utilize applicants. EPAS has been specifically designed to use these measures; REQUEST, on the other hand, would have to be modified to accept these new predictors.

In addition, the EPAS-enhanced sequential classification algorithms must have a factor which will enable them to accept the relative PJM score generated by the optimization procedures. This capability is required to differentiate among the relative merit of allocation combinations.

For example, if the relative [optimal] scores for two combinations were 1000 and 995, there is little substantial difference between the two. The final decision could, in effect, be based on other factors in the classification algorithm. If the scores were 1000 and 500, however, a significant preference of one over the other is being indicated and must be addressed.

Results of Interfacing with REQUEST

The net effect of these two different approaches is a totally different list of recommended MOS. Table 2, for example, shows the list of recommended MOS generated by the two approaches for the same two applicants.

Both the applicants in Table 2 were male, high school graduates. One was in AFQT Category II, with an AFQT score of 88; the other, AFQT Category IIIA, with an AFQT score of 60. Both applicants were processed through REQUEST; they were then processed using the EPAS-generated optimal guidance.

As one compares the MOS recommendations, it is clear that the EPAS-enhanced system generates a markedly different list than that generated by REQUEST for any given individual. None of the REQUEST-generated recommendations are on the EPAS recommendations for either of the two individuals depicted in Table 2.

In addition, the ordered list from REQUEST is virtually identical for the two applicants. The only distinction between the two lists is the result of the AFQT Category II individual meeting a qualifying score which the AFQT Category IIIA individual fails.

EPAS, on the other hand, produces a distinctly different list for the two applicants. This distinction reflects the impact of both examining different MOS (utilizing EPAS guidance) and using different scoring procedures (accepting new predictors).

Clearly, the difference in methodology between EPAS and REQUEST has a significant impact on the outcome. If the results of this research effort are to be successfully applied, joint research is required with the Army, GRC, and REQUEST contractor personnel to determine suitable means by which the existing system's algorithms can be modified to accept the EPAS ordered lists.

TABLE 2
COMPARATIVE MOS RECOMMENDATIONS

Applicant One
AFQT Category IIIA

ORDER No.	REQUEST	EPAS
1	13B	26L
2	98C	27B
3	63T	27N
4	11X	32D
5	29F	32G
6	94B	32H
7	96R	34Y
8	31C	35L
9	63D	35M
10	93B	35R

Applicant Two
AFQT Category II

ORDER No.	REQUEST	EPAS
1	13B	13C
2	98C	13E
3	63T	13F
4	11X	19D
5	33T	27M
6	29F	36C
7	94B	41C
8	96R	41J
9	31C	45B
10	63D	45K

V. EPAS APPROACH
EPAS SYSTEM FRAMEWORK

To meet the needs of this research, EPAS had to be developed within a user-friendly, interactive, computerized system framework. This enables the evaluation of interdependent methodologies in a controlled environment and supports test scenarios.

A detailed discussion of the characteristics and key features of the EPAS system framework may be found in Appendix A. The basic features are summarized below.

SYSTEM FRAMEWORK

The system framework, called the Process Test System (PTS), provides several features to facilitate development, testing, and analytical support. The significant aspect of the PTS from the user's standpoint is its use of interactive menus to control all aspects of the system. Figure 8 presents an example of a typical menu as implemented in the EPAS user interface. These menus allow the EPAS user to easily set up alternate scenarios and control their execution and analysis.

STANDARDIZED EDITORS

All data within EPAS is accessable to the user through a series of interactive editors. Access to the full spectrum of data provides the ability to easily alter any data within the model for policy analysis and the ability to query the current or simulated values for any part of the system. All editors have been standardized to provide identical capabilities.

EXECUTION CONTROL

The EPAS prototype has been developed to be usable, as well as useful. The execution control procedures within the PTS perform all actions necessary to generate and execute the model in accordance with the user's specifications.

REPORT RESULTS

If the policy analysis capabilities of EPAS are to be utilized, the Army analyst must be able to generate clear, precise reports describing the results of the simulations. The user may select desired reports as an execution is being formulated. These reports will then be generated automatically.

NPS ENLISTED PERSONNEL ALLOCATION SYSTEM V3R2

EPAS Controller Policy File Editor Selection PTS-05

Select one of the following policy file editors

—> Quality Forecasting Module Policy File Editor

Quality Allocation Module Policy File Editor

Applicant Classification Module Policy File Editor

...Return to Data File Operations Selection Menu

Figure 8. Sample EPAS Interactive Menu

The user may also request the generation of reports after the model execution has been completed. To facilitate this option, EPAS automatically computes summary statistics as the model executes. When after-the-fact reports are requested, these summary files are accessed to speed the report generation process. Full detail is also kept after each iteration, so detailed queries may also be generated if desired.

VI. PROGRESS SINCE LAST REPORTING PERIOD

This section discusses the work that has been performed in support of the development of EPAS since the last reporting period, encompassing December 1987. The subsections that follow present project research, problems encountered, products and reports, meetings, and financial information.

PROJECT ACTIVITIES

Task 4.1: NPS EPAS Development

Version 3 of EPAS has been successfully transferred to the National Institute of Health (NIH) Computer Facility and verified against the WICAT version of the model.

Task 4.2: Cost-Benefit Analysis

The Cost-Benefit Analysis has been completed and delivered to ARI. A review of the analysis was held May 21, 1986.

Task 4.3: Enlisted Retrainee Addition to NPS EPAS

This task is currently inactive.

Task 4.4: MMM Comparison with EPAS

Analysis of current MMM (i.e., REQUEST MOS Search Algorithm) resumed for identification of the best means for interfacing EPAS and REQUEST.

Task 4.5: EPAS Supported Analyses

No activities for this reporting period. Additional activities have been suspended pending transfer to an Army computer facility.

Task 4.6: EPAS Refinements

No activities for this reporting period. Additional activities have been suspended pending transfer to an Army computer facility.

Task 4.7: Documentation of EPAS

Detailed documentation of the EPAS' structure and data flow continued using the Information Engineering Workstation (IEW) software package.

PROBLEMS ENCOUNTERED OR ANTICIPATED

This contract needs to be extended to coincide with completion of Project A. This action is necessary to support two contract activities, specifically:

(1) Supporting Project A analyses

(2) Implementation of Project A performance predictors

A contract modification is necessary to transfer EPAS to an Army computer facility. This action will provide the following capabilities:

(1) Reduction of Operational Costs. ARI pays for all computational and storage expenses on the NIH facility. Having verified the EPAS concept, significant reduction of these computer-associated costs can be achieved by transferring EPAS to an Army facility for future analysis and development.

(2) Tie-In with Operational Data. All EPAS research and development to date have utilized manually created data files. Future development will require access to actual (operational) data sources.

(3) Field Test Environment. The contract specifies that the field test must be conducted in an operational environment, such as would be found on an Army computer.

GRC's recommendation is that EPAS be transferred to the Army's ISC-P computer facility.

PROJECT PRODUCTS PRODUCED

No activities for this reporting period.

PROJECT REPORTS PRODUCED

No activities for this reporting period.

SUMMARY OF BRIEFINGS, MEETINGS, VISITS, OR SEMINARS

1 May 1987 - Meeting at GRC to discuss EPAS. Participants were Roy Nord, Edward J. Schmitz, Dr. Peter McWhite, George Brown, and Frank Konieczny.

1 July 1987 - Meeting at USAREC, Fort Sheridan, Chicago, IL with MAJ Brandon Smith, RO-EA and George Brown, GRC.

12 August 1987 - Meeting at ARI to discuss EPAS briefs. Participants were Drs. Eaton, Gilroy, and (Darlene) Olsen and Edward J. Schmitz, ARI; Dr. Harris, HumMRO; and Dr. Peter McWhite, GRC.

26 August 1987 - Meeting at ARI to discuss EPAS Field Test. Participants were Edward J. Schmitz and Mr. Nord, ARI and Dr. Peter McWhite and Frank Konieczny, GRC.

27 August 1987 - Briefing at USAREC to discuss EPAS. Participants were COL Reese, Director Recruiting Operations and prospective Chief of Staff, LTCs Cox and Easley, USAREC and Dr. Gilroy and Edward J. Schmitz, ARI.

2 September 1987 - Meeting at ODCSPER to prebrief EPAS. Participants were LTCs Cannaday and Frame, ODCSPER Accessions; Edward J. Schmitz, ARI and Dr. Peter McWhite and George Brown, GRC.

3 September 1987 - Briefing for MG O'Leksy on EPAS. Participants were MG O'Leksy, Director of Military Personnel Management; COL Jewel and LTC Cannaday, ODCSPER and Dr. Gilroy and Edward J. Schmitz and Roy Nord, ARI.

10 November 1987 - Meeting at GRC to discuss future EPAS computer requirements. Participants were Edward J. Schmitz, ARI, and Dr. Amir Eiger, Frank Konieczny and George Brown, GRC.

7 December 1987 - Meeting at GRC to discuss implications of methodological differences between current Army search algorithm and EPAS. Participants were Edward J. Schmitz and Roy Nord, ARI, and Frank Konieczny and George Brown, GRC.

15 December 1987 - Briefing at GRC on EPAS computer requirements. Participants were LTC D. Michael and CPT R. Basinger, SFF; Edward J. Schmitz, ARI; and Charlie Smith, Mr. Henry Weigel, Frank Konieczny and George Brown, GRC.

21 December 1987 - Meeting at Pentagon to discuss current REQUEST MOS search algorithm. Participants were MAJ Fay, DAPE-MPF; Edward J. Schmitz, ARI; and Frank Konieczny and George Brown, GRC.

PROFESSIONAL PERSON-MONTHS

(Based on 160 person-hours per month.)

November	Total to Date	Remaining in Contract
3.66	427.07	54.43

FUNDS EXPENDED (EXCLUSIVE OF FEE)

(Based on GRC FY 1988 provisional indirect rates)

November	Total to Date	Remaining in Funding Increment	Remaining in Contract
$32,975	$3,704,361	$113,294	$320,851

PROFESSIONAL PERSON-HOURS WORKED

STAFF	TASK	PERSON-HOURS
Dr. Eiger	4	4.0
Mr. Weigel	4	4.0
Dr. McWhite	4	7.0
Mr. Bavis	4	10.0
Mr. Brown	4	132.5
Mr. Konieczny	4	12.5
Mr. Hutton	4	143.0
Mr. Hudson	4	116.5
Mr. Stewart	4	121.0
Mr. Webber	4	31.2
Ms. Evans	4	4.0
Total Person Hours		585.7

TECHNICAL SUPPORT

No technical support activities this month.

COMPUTER AND DATA BASE ACTIVITIES

Computer-related activities this month consisted primarily of supporting the development of a prototype EPAS at the National Institute of Health Computer Facility. Costs for these activities totaled $9,664.54.

APPENDIX A
OVERVIEW OF EPAS ANALYSIS

The currently operational version of EPAS is the product of a series of analyses conducted by personnel associated with the project. This analysis has been conducted primarily by GRC personnel; however, analyses performed by ARI and AIR (Project A) personnel were also utilized in the system's development.

The results of the analyses have been extensively documented in previous GRC reports. A brief summary of the history of the research and decisions for each of the major functional areas of EPAS is included in this appendix to provide the reader with an overview of the EPAS design and development. References to the earlier documentation are included in case the reader desires more detailed information on a specific research issue.

For the convenience of the reader, the material in this appendix is organized along the same functional lines as were described in the body of the report. Procedures covered are:

(1) Forecast Applicants/Contractees

(2) Determine/Project MOS Requirements

(3) Generate Aggregate Assignments

(4) Generate Detailed Assignments

(5) EPAS System Framework

FORECAST APPLICANTS/CONTRACTEES

The contract specifications for EPAS listed supply forecasting as one of its key system capabilities:

> "the determination of a reasoned guess about the number and kind of people likely to be available for recruitment into the Army during some specific week, month or year"

To meet this requirement, it was obvious that a supply forecasting capability would have to be implemented into EPAS.

A related problem, which wasn't explicitly specified in the contract but which became essential to the development of EPAS, was the necessity to aggregate the supply. The Army's non-prior service assignment problem is unique in its size and complexity. Typically, 140,000 individuals apply each year for training seats in 300 or so MOS. The total number of training classes available during the year is approximately 6000. Without considering the eligibility restrictions, this gives 140,000*6000 or 840,000,000 possible assignments. A problem of this magnitude could not be solved using existing computer hardware.

To overcome this problem, contractees were aggregated into categories called Supply Groups. This categorization was based on demographic and performance characteristics, since this supported the Army's person-job assignment problem. This categorization, along with a similar grouping for MOS (described in the next section) provided a reduction in the magnitude of the problem on the order of 10,000. With this technique, two research issues arose.

(1) How should the supply of contractees be aggregated to provide the most benefit to the assignment problem?

(2) How should the projections from the forecasting models be used to provide Supply Group projections?

To successfully support these requirements, four functional areas were identified. They are:

(1) Conduct a literature and data review of forecasting techniques appropriate for estimating the near- and long-term supply of Army applicants. This provided the groundwork for model development.

(2) Review the Army's recruit mission process. Before trying to develop this capability, it was necessary to understand the system.

(3) Select appropriate forecasting methodologies for EPAS.

(4) Investigate and select appropriate Supply Group formulation methodologies.

Conduct a Literature and Data Review of Forecasting Techniques

This functional requirement was specified as Subtask 2 of Task 1 in the EPAS contract. It was clearly undesirable for GRC personnel to replicate the efforts of other contracts and agencies in the development of forecasting methodologies. A survey of NPS supply forecasting methodologies was conducted to identify existing capabilities. Additionally, a subcontract was let to Adaptronics, Inc. to perform a survey of general forecasting techniques. The results of these surveys are summarized below.

Survey of NPS Supply Forecasting Technology. The majority of the NPS supply forecasting models could be classified into one of two categories, macro or micro, based upon their level of aggregation. The traditional models regressed counts of enlistee supply against population counts, measures of unemployment, military and civilian pay measures, and other related socioeconomic variables. These models are regarded as macro models. These included models developed by Fernandez (1979, 1980) at RAND, Goldberg (1979, 1980) at CNA and Morey (1979, 1980) at Duke University.

Other models, identified as micro models, were developed using choice-based sampling methods. Daula (1982) criticized macro models as suffering from the effects of aggregation and measurement errors, as well a sampling bias which he attributed to the fact that civilian wages and opportunities could not be observed for those individuals who enlisted in the military. Daula further conjectured that, because of these errors, the historical estimates of elasticities for pay and unemployment had been drastically underestimated.

Using a choice-based methodology like that of Hausman (1978) and Manski (1977), Daula and his colleagues at the U.S. Military Academy developed a micro model of individual behavior. Preliminary results were encouraging, but they did suffer from some counter-intuitive appeal, e.g. the mathematical formulation resulted in recruiter performance having a negative contribution to the final results.

However, the major problem with Daula's work was the lack of adequate data. Daula was using data from the National Longitudinal Survey (NLS) that had been sponsored by the Department of Labor. This data base had only a small sample of military personnel records. Hosek (1982) of RAND Corporation was able to construct a much larger data base by merging data collected at the AFEES with the NLS data, but the results of his choice-based model were not available.

The NPS supply forecasting survey revealed work had been done in this area, but that much more was needed. Most of these models were developed for long-term (i.e. a year or more) forecasting. In addition, they all projected accessions of male high school graduates in AFQT Category I-IIIA. EPAS, however, required forecasts of all contracts.

Survey of General Forecasting Techniques. EPAS's forecasting requirements were expected to pose problems not encountered by the current NPS supply forecasting research. Therefore, it was decided that a survey covering the current state of forecasting methodologies, in general, should be conducted. Adaptronics, Inc. was carried out this survey. The survey was done by James Carrig (1983).

The survey presented an overview of current forecasting methodology along with a critique of how well these methods had done in the forecasting competition set up by Makridakis (1982). This competition contained 1001 sets of time series of all types of data including monthly, quarterly, yearly; seasonal and nonseasonal; and micro and macro data.

Carrig also tested a new forecasting technique, the Adaptive Learning Network (ALN). This method was compared to the more accurate of the major forecasting methods using a randomly-selected subset of 111 time series from the 1001 sets used in the Makridakis competition.

The major conclusion drawn from this survey was that no single forecasting method is best in all circumstances. It was evident that data analysis should be done to determine if the time series exhibit any of several common characteristics, for example, seasonality. Given these characteristics, one can then narrow down the possible model choice(s) to a subset of methods that have perform well with that type of data.

Review the Army's Recruit Mission Process

The Army currently states its requirements for recruits as "missions" grouped by gender, education level, and categories based on the Armed Forces Qualification Test (AFQT). The groups are:

(1) Gender - male or female.

(2) Education level.
- high school diploma graduate or senior.
- less than high school graduate.

(3) AFQT Category.
- I-IIIA for AFQT 50-99.
- IIIB for AFQT 31-49.
- IV for AFQT 16-30.

The AFQT, which is a combination of four subtests from the Armed Services Vocational Aptitude Battery (ASVAB), is used to determine whether the individual is qualified for entry into the Army. In addition, various limits and goals are set on enlistee AFQT quality by Congress, the Department of Defense, and the Army. For example, Congressional limits are set on the number of recruits in AFQT Category IV, while Army targets are set on the number in AFQT Categories I-IIIA.

Gender and education level are other individual characteristics used in the Army's accession planning. High school diploma graduates are preferred to nongraduates. Seniors can't be accessed into an MOS until after graduation. Gender is important since women are restricted from combat, and these type of jobs comprise about a third of the Army's entry positions.

The Quality Requirement. Aggregate accession requirements are generated by the Office of the Deputy Chief of Staff for Personnel (ODCSPER) with the use of the Enlisted Loss Inventory Model and the Computation of Manpower Programs using Linear Programming System (ELIM-COMPLIP). This system minimizes the differences between established operating strength objectives and actual strength forecasts, and incorporates a number of constraints such as total Army training capacities.

Army manpower planners review the aggregate accession requirements and Congressional limits to develop quality targets. Thus, AFQT Category IV accessions are capped by Army policy and Congressional limits, while Category I-IIIA targets are established by Army policy. AFQT Category IIIB personnel are neither targetted nor capped; instead these accessions "float" to allow the Army to meet its overall accession requirement. Table A-1 shows the fiscal year 1984 accessions by mission area.

The Recruiting Accession Requirement. ELIM-COMPLIP accession requirements are on a calendar month basis. The U.S. Army Recruiting Command's (USAREC) missioning, however, is done on a Reception Station Month (RSM) basis. A RSM consists of either four or five 7-day weeks that begin on Tuesday and end on Monday. The RSM concept ties the recruiting program to the start of training. It also smooths the peaks and valleys of recruit arrival at the training bases by eliminating the potential for large increases in accessions at the end of the calendar month. The ODCSPER converts the calendar month accession requirements into RSM accessions objectives for USAREC on a quarterly basis; an accession is defined as the point when an individual arrives at a reception station to begin basic training.

USAREC apportions the accessions objectives into contract/recruiting missions to the District Recruiting Battalions, formerly referred to as Commands, on a recruit station month (RSM) basis. Contracts are defined at the point at which an individual takes the oath of military

TABLE A-1

ACCESSIONS FOR FY84 BY RECRUITING MISSION AREA

		AFQT CATEGORY		
GENDER	DIPLOMA	I-IIIA	IIIB	IV
Male	High School	64868	29501	13260
	No High School	3915	14	2
Female	High School	12514	4174	12

service and has a training seat reserved. EPAS is primarily concerned with contractees since the assignment of the MOS is made at that point.

Contract Missions. A recruit signs a contract obligating him to report for active duty and training for an MOS. The Delayed Entry Program (DEP) enables recruits to report at a later time to be accessed. Management of the DEP is complex, because neither the supply of potential recruits nor the phasing of MOS training classes is constant throughout the year. A failure to contract with an adequate number of recruits to access in months where recruiting is difficult can cause shortfalls in accessions.

The Army uses nine aptitude area composites from the ASVAB to determine the minimum qualifications for the MOS. If an individual scores above the minimum qualifying score on the proper aptitude area composite, then the individual may train for that MOS, provided a training seat exists. Table A-2 gives the ASVAB aptitude areas and the major jobs in the Army associated with each.

Select Appropriate Forecasting Methodologies for EPAS

EPAS' main goal was to provide forecasts of the number and type of people who will accept Army enlistment contracts for the short and long run. EPAS requires these forecasts for all mission areas on a RSM basis. The literature and data review revealed very little work being done to project such contracts. Therefore, it was decided that ARI would perform the principal development of new models. In addition, GRC developed and implemented two models to facilitate the implementation of the EPAS forecasting capability.

One analysis considered the USAREC mission goals as a forecasting model. This seemed a reasonable hypothesis given that recruiters are evaluated on how well they meet their goals. Of course, this is assuming the supply is there to meet the demand. This analysis along with a description of the forecasting models currently implemented in EPAS is presented below.

USAREC Mission Goals as Forecasts. Historically, the Army's demand for quality (high school graduates in AFQT Categories I-IIIA) males have not been met by the available supply. GRC performed an analysis to determine if this was still the case or whether the supply of this and other mission groups could be determined largely by their USAREC mission goals. The analysis used FY81 and FY82 data. Prior to FY81, mission statements did not provide the necessary detail. Recruiting missions were stated only in terms of total accessions.

Table A-3 displays the overall goal achievement by mission for these two years. Success in recruiting increased in FY82 over FY81 with only two lower quality categories failing to reach their stated mission. During FY81, USAREC exceeded its combined contract mission for quality males (27,148 contracts) by seventeen percent (31,957). In FY82,

TABLE A-2
COMPOSITION OF APTITUDE AREAS

APTITUDE AREA	MAJOR JOBS IN EACH APTITUDE AREA
CL (Clerical)	Administrative, Supply, Finance
CO (Combat)	Infantry, Armor, Combat Engineer
EL (Electronics Repair)	Missiles Repair, Air Defense Repair, Electronics Repair, Fixed Plant Communications Repair
FA (Field Artillery)	Field Cannon and Rocket Artillery
GM (General Maintenance)	Construction and Utilities, Marine, Chemical, Petroleum
MM (Mechanical Maintenance)	Mechanical and Aircraft Maintenance, Rails
OF (Operators and Food)	Missiles Crewmen, Air Defense Crew, Driver, Food Services
SC (Surveillance and Communications)	Target Acquisition and Combat Surveillance, Communications Operations
ST (Skilled Technical)	Medical, Military Police, Intelligence, Data Processing, Air Control, Topography and Printing, Information and Audio Visual

USAREC nearly doubled the size of this mission goal (45,391) and still exceeded it by thirteen percent (51,431 contracts). This was accomplished by recruiting fewer AFQT Category IIIB high-school graduates than were permitted.

Table A-4 displays the monthly contract missions and achievements, aggregated by District Recruiting Command (DRC), for quality males. About 30 percent of all observations apparently failed (by DRCs) to achieve monthly quality contract missions. A closer look, however, revealed that less than twelve percent of all observations showed a cumulative year-to-date deficit in quality contract achievement, and only six percent failed to meet at least 90 percent of their annual quality goals and their monthly quality mission goals.

Hence, the FY81-FY82 data suggests that quality contracts were not supply constrained relative to USAREC missions. In fact, the USAREC mission goals provide good forecasts of enlistment contracts.

TABLE A-3
GOAL ACHIEVEMENT BY MISSION BOX

MISSION BOX	FY 81 GOAL	FY 81 ACHIEVEMENT	FY 81 % GOAL	FY 82 GOAL	FY 82 ACHIEVEMENT	FY 82 % GOAL
M/HS*/I-IIIA	27148	31957	117.7	45391	51431	113.3
M/NHS/I-IIIA	10200	9957	97.6	8953	10810	120.7
M/HS*/IIIB	30920	16581	53.6	23549	25211	107.1
M/NHS/IIIB	16269	15859	97.5	0	600	--
M/HSDG/IV	26941	26060	96.7	22419	21321	95.1
M/NHS/IV	0	0	0.0	0	0	0.0
F/HS*/I-IIIA	6660	8425	126.5	8897	11764	132.2
F/NHS/I-IIIA	246	469	190.7	0	50	--
F/HS*/IIIB	9089	6913	76.1	3197	2673	83.6
F/NHS/IIIB	173	472	272.8	0	1	--
F/HS*/IV	2674	3117	116.6	0	56	--
F/NHS/IV	0	0	0.0	0	0	--
TOTAL	130320	119810	91.9	112406	123917	110.2

HS* - indicates both high school graduates and high school seniors

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TABLE A-4
FAILURES TO ACHIEVE HIGH-QUALITY CONTRACT MISSIONS

CONDITION	FY	NUMBER DRCs	NUMBER FAILURES	TOTAL OBS	% of TOTAL OBS
Failure to achieve monthly quality mission	81	49	219	684	32.0
	82	54	179	672	26.6
	81-2	103	398	1356	29.4
Failure to achieve monthly quality mission and cumulative year-to-date quality mission	81	19	88	684	12.9
	82	21	72	672	10.7
	81-2	40	160	1356	11.8
Failure to achieve monthly quality mission and annual quality mission	81	15	113	684	16.5
	82	7	54	672	8.0
	81-2	22	167	1356	12.3
Failure to achieve monthly quality mission and 90% annual quality mission	81	8	72	684	10.5
	82	1	9	672	1.3
	81-2	9	81	1356	6.0

Currently Implemented Contract Forecasting Models. EPAS required Supply Group forecasts on a RSM basis. The first step to providing this capability was forecasting contracts at the mission level. Consequently, five forecasting models were developed and implemented. Two were developed by ARI, two by GRC, and one based on the USAREC mission goals. The forecasting models currently implemented in EPAS are:

(1) Dale-Gilroy (ARI) econometric model.

(2) Horne (ARI) econometric model.

(3) USAREC mission statements.

(4) GRC trend model.

(5) GRC econometric model.

Since these models did not provide the necessary detail, modifications had to be made. Except for the USAREC mission goals model, the models only provided contract forecasts for male, high school graduate, AFQT Category I-IIIA missions. USAREC mission goals were used, therefore, to forecast the remaining mission categories.

Three of the models generated forecasts by calendar month, while the Horne model forecasted quarterly. Adjustments were necessary to provide forecasts by RSM. Since each RSM is comprised of days from at most two calendar months, the RSM forecast was generated by summing together weighted calendar forecasts. The weight used is the percentage of the calendar month accounted for by the RSM. Finally, the USAREC mission goals had to be broken down to provide contracts on a RSM basis. Historical contracts by RSM and by mission category were used to generate the necessary detail.

Dale-Gilroy Econometric Model. The econometric model developed by Dale and Gilroy (September, 1983) estimated the effects of business cycles on monthly military accessions. This model uses the ratio of quality male contracts signed (accession contracts and DEP-in contracts) to the civilian male population in the 16-19 age group as the dependent variable. The explanatory variables included:

(1) Unemployment rates for males age 16-19 in the current month, and lagged both two and four months.

(2) The ratio of regular military compensation to average weekly civilian production wages with a four month lead.

(3) Enlistment bonuses.

(4) Educational bonuses.

(5) Number of recruiters.

The model was estimated using generalized least squares (GLS) regression, correcting for the presence of first order autocorrelation. The data covered the time period from October, 1975 to March, 1982, and was obtained from the Defense Manpower Data Center (DMDC). Their findings showed that quality enlistees are especially affected by pay rates. They also concluded that it is important for the Army to maintain military-civilian pay comparability, as well as educational benefits, in order to have continued success in recruiting quality soldiers.

Horne Econometric Model. Horne (May, 1984) estimated the quarterly supply of contracts from several economic variables. The dependent variable was the ratio of quality male contracts to the civilian male population in the 16-21 age group. The explanatory variables included:

(1) Military and civilian pay differential.

(2) Enlistment bonus.

(3) Civilian unemployment in the 16-21 age group, lagged one quarter.

(4) Ratio of the number of recruiters to the civilian population in the 16-21 age group.

The Horne model was estimated using generalized least squares regression. The quarterly data covered third quarter of 1977 through the second quarter of 1984. His findings showed that military pay has a large and significant impact on enlistments, and that meeting recruiting goals is strongly hampered by declining unemployment rates and declining population of eligible males.

Since USAREC conducts recruiting on a monthly basis, historical monthly percentages were applied to generate monthly forecasts from the quarterly forecasts.

USAREC monthly mission model. As previously stated, the USAREC monthly mission statements provided a good forecast of the contractee supply. Therefore, the mission statements were included as a model for contractee supply.

GRC Econometric Model. The variables used in the Dale-Gilroy model are all highly correlated. To adjust for this, and to avoid multicollinearity problems in the regression analysis, GRC used the technique of principal components to create a new set of exogenous variables from linear combinations of the original variables. These new variables have the property of being mutually uncorrelated. A linear regression was performed to generate coefficient estimates for these new variables. The monthly ratio of the number of quality male contracts to the civilian male population in the 16-21 age bracket is used as the dependent variable. Corrections were also included for the presence of first order autocorrelated errors.

GRC Trend Model. GRC also developed a linear trend model. The monthly contractee data is seasonally adjusted and a linear trend fit performed without any exogenous variables. The form of the model is:

$$Y = f(T,S)$$

where Y is the number of contractees, T is the time trend, and S are past values of Y from previous months.

The time trend is first estimated using regression. The remaining variation or "forecast errors" are then modeled with autoregressive or lag parameters to arrive at the final form of the forecast model. An intuitive justification for this approach is that recruiters "bank" quality recruits at the end of the month once that month's recruit mission has been satisfied.

Investigate and Select Appropriate Supply Group Methodologies

The goal in defining Supply Groups was a reduction in problem size while maintaining differential (expected) performance characteristics that could be seen in the individual recruits. Four functional areas were identified to meet this goal:

(1) Investigate and select clustering techniques.

(2) Evaluate and select the supply subpopulations.

(3) Develop Supply Group methodologies.

(4) Develop Supply Group forecasts.

Investigate and select clustering techniques. The aim of clustering techniques is to develop groups or clusters of similar individuals or objects. These techniques have been used and developed in many fields, including statistics, biology, and psychology. Their complexity ranges from simple intuitive approaches to complex graph theoretic and probabilistic models. The similarity criterion is one of the things that differentiates one method from another. For example, have nine aptitude area composites measure the individual's expected performance. Some common criterions, stated in terms of these measures, are:

(1) Euclidean criterion or metric, where the measure of similarity is the square root of the sum of squared differences in the aptitude area composites.

(2) City-block criterion or metric, where the similarity is based on the sum of absolute differences in the respective composites.

(3) Standard correlation coefficient.

Most clustering algorithms can be classified as either hierarchical or nonhierarchical.

Hierarchical methods seek to produce a set of nested clusters ranging from one cluster containing all the objects to many clusters where each contain only one object. These methods can be further classified as either agglomerative or divisive approaches. Agglomerative algorithms start with each individual or object as a cluster, and proceed by a series of pairwise mergings of these objects until one cluster containing all the objects is derived. Divisive methods begin with all the objects or individuals as part of one cluster, and proceed by a series of successive splittings until a set of many clusters with one object in each is obtained.

In nonhierarchial cluster analysis, the number of clusters is assumed to be known beforehand; the process is to identify those clusters. Some of the more common of these approaches are:

(1) Nearest centroid sorting

(2) Hill climbing

(3) Mode seeking or density search.

Based on the characteristics of the data being processed, EPAS currently uses a nearest centroid sorting approach. Details of the implementation of this technique are described in a subsequent section, <u>Principal Coomponents Based Supply Groups</u>.

<u>Evaluate and Select the Supply Subpopulations</u>. Prior to any supply aggregation, the supply population is stratified into subpopulations based on the mission categories, gender, education level, and AFQT Category. This stratification facilitates the assignment process, allowing the models to address the various Army policies, e.g., gender restrictions.

Since the jobs (MOS) side of the assignment problem stated its eligibility requirements in terms of mission categories, a similar breakdown of the supply side was selected. Some minor modifications were made to these subpopulations to further improve the aggregate assignment model, specifically:

(1) The AFQT Category I-IIIA was split into its two quartiles, I-II and IIIA. This improved the differentiability of the subpopulations.

(2) Since EPAS has to treat high school seniors different from graduates (seniors aren't available for assignment until after graduation) a high school senior category was added to the education level.

(3) To completely account for the entire supply population, the defined AFQT Categories were extended to female, high school seniors and graduates. This process included categories not defined in the mission areas, but the potential application of EPAS to hypothetical policy alternatives necessitated definition of the entire supply population.

Table A-5 displays a list of the subpopulations developed from these definitions.

Develop Supply Group Methodologies. Individuals were clustered in the supply population using the performance measures, or a function thereof, as the clustering variables. Currently, these measures consist of the aptitude area composites. The resulting clusters are the Supply Groups. Their corresponding performance measure would be an aggregate measure of the individuals, e.g. the average aptitude area composites taken over all individuals in each cluster. The clustering algorithm is applied to the subpopulations and not to the supply population itself. This enabled definition of Supply Groups divided by differentiable performance measures while maintaining policy-unique attributes.

Two clustering approaches have been developed and implemented which, based on experience, were consistent with the data. The first approach used a nearest centroid sorting algorithm to cluster a function of the aptitude area composites; the second, Ward's minimum variance.

Principal Components Based Supply Groups. The first Supply Groups were formulated for the FY84 supply of enlistment contracts using the statistical technique, principal components, and a nearest centroid sorting algorithm (SAS procedure, FASTCLUS) for clustering. This approach was later used to generate Supply Groups for the FY86 data.

One characteristic, common to all of the mission-based subpopulations, is the high intercorrelations exhibited by the aptitude area composites as shown in Tables A-6 and A-7. The principal components technique was used to transform the aptitude area composites into a set of uncorrelated scores, called principal components. These new scores account for the same amount of variability as exhibited by the original aptitude area composites.

A trait of this technique is that succeeding components account for a smaller proportion of the variability, e.g. the first principal component would account for the largest percentage. If a small number of components accounted for a large proportion of the variability, then one would only need to apply the clustering algorithm to this reduced set of scores.

TABLE A-5

SUPPLY SUBPOPULATIONS BASED ON MISSION CATEGORIES

NO.	GENDER	EDUCATION LEVEL	AFQT CATEGORY	% FY84 SUPPLY	% FY86 SUPPLY
1	M	HSG	I-II	20.9	25.0
2	M	HSG	IIIA	10.7	15.8
3	M	HSG	IIIB	19.6	22.9
4	M	HSG	IV	11.2	4.4
5	M	HSS	I-II	3.4	3.3
6	M	HSS	IIIA	2.4	2.6
7	M	HSS	IIIB	4.8	2.8
8	M	HSS	IV	.5	.1
9	M	NHS	I-II	4.1	3.4
10	M	NHS	IIIA	4.9	5.6
11	M	NHS	IIIB	3.5	.4
12	M	NHS	IV	1.0	<.1
13	F	HSG	I-II	4.3	4.8
14	F	HSG	IIIA	3.1	4.1
15	F	HSG	IIIB	4.3	4.1
16	F	HSG	IV	.3	<.1
17	F	HSS	I-II	.4	.3
18	F	HSS	IIIA	.4	.3
19	F	HSS	IIIB	.2	.1
20	F	HSS	IV	≤.1	≤.1
				100.0	100.0

TABLE A-6

FY84 CORRELATIONS OF APTITUDE AREA COMPOSITES FOR MALE, HIGH SCHOOL GRADUATES, IN AFQT CATEGORY I-II

	APTITUDE AREA								
APTITUDE AREA	CL	CO	EL	FA	GM	MM	OF	SC	ST
CL	1.0	.6	.8	.8	.7	.5	.5	.7	.8
CO		1.0	.6	.8	.7	.8	.8	.9	.7
EL			1.0	.7	.9	.6	.4	.6	.7
FA				1.0	.6	.6	.5	.7	.7
GM					1.0	.8	.6	.8	.8
MM						1.0	.9	.9	.8
OF							1.0	.8	.8
SC								1.0	.8
ST									1.0

TABLE A-7

FY84 CORRELATIONS OF APTITUDE AREA COMPOSITES FOR MALE, HIGH SCHOOL GRADUATES, IN AFQT CATEGORY IIIA

	APTITUDE AREA								
APTITUDE AREA	CL	CO	EL	FA	GM	MM	OF	SC	ST
CL	1.0	.3	.7	.7	.5	.1	.1	.4	.5
CO		1.0	.4	.7	.7	.8	.7	.9	.6
EL			1.0	.6	.8	.3	<.1	.5	.4
FA				1.0	.4	.4	.3	.5	.5
GM					1.0	.8	.6	.8	.7
MM						1.0	.9	.8	.7
OF							1.0	.8	.8
SC								1.0	.7
ST									1.0

TABLE A-8

PERCENTAGE OF APTITUDE AREA (BY MISSION)
VARIABILITY ACCOUNTED FOR BY
THE FIRST PRINCIPAL COMPONENT

NO.	GENDER	EDUCATION LEVEL	AFQT CATEGORY	% FY84 VARIABILITY	% FY86 VARIABILITY
1	M	HSG	I-II	75	75
2	M	HSG	IIIA	63	65
3	M	HSG	IIIB	60	66
4	M	HSG	IV	54	55
5	M	HSS	I-II	72	73
6	M	HSS	IIIA	63	65
7	M	HSS	IIIB	58	67
8	M	HSS	IV	51	58
9	M	NHS	I-II	70	71
10	M	NHS	IIIA	63	65
11	M	NHS	IIIB	58	65
12	M	NHS	IV	51	63
13	F	HSG	I-II	75	76
14	F	HSG	IIIA	57	60
15	F	HSG	IIIB	55	51
16	F	HSG	IV	45	41
17	F	HSS	I-II	72	78
18	F	HSS	IIIA	60	59
19	F	HSS	IIIB	55	63
20	F	HSS	IV	61	43

As anticipated, the first principal component accounted for a substantial portion of the variability, typically ranging from 50 to 75 percent and increasing with higher AFQT Category (see Table A-8). Adding the second principal component increased this to 75-90 percent.

For this first formulation, model simplicity was maintained by using only the first component. This was based on the assumption that it was more important to verify the operational feasibility of EPAS than to conduct extensive analyses.

To cluster the first principal component, a nearest centroid sorting algorithm was used, specifically that used by the SAS procedure FASTCLUS. This algorithm is designed for clustering large data sets, as is the case with the supply subpopulations. A limit of no more than three clusters (Supply Groups) per subpopulation was imposed because of computer constraints.

For these clusters, an aggregate measure of performance was needed which would be used to differentially assign the Supply Groups. The average aptitude area composites were selected for this aggregate measure based on analysis performed by Project A which validated the ASVAB Aptitude Area scores as a predictor of performance (McLaughlin, et al, 1984). Table A-9 contains the FY84 Supply Groups resulting from this process; Table A-10 has the FY86 Supply Groups. The %Mission column is the percentage of the subpopulation attributed to the Supply Group.

A few observations are in order: for subpopulations generally not recruited (female, seniors in AFQT Category IV), there wasn't enough variability in the aptitude area composites to get more than three Supply Groups. In fact, in the FY86 Supply Groups there were no individuals in this category. The distribution of female, high seniors in AFQT Category IIIB was truncated at AFQT score 40 and below, and used to develop the Supply Groups.

Also, the differentiability across Supply Groups within each mission subpopulation is considerable, whereas the individual Supply Groups tended not to be differentiable across their aptitude area composites. Considering the large size of the subpopulations and the use of only three categories to represent their aggregate behavior, this is not unexpected.

Supply Groups using Wards' Clustering Algorithm. Early in 1987, an effort was initiated to improve Supply Groups. The goal was to increase differentiability while maintaining the policy-specific requirements. A different approach was taken to deal with the high intercorrelations in the composites. Instead of clustering on a function of these scores, i.e. the first principal component, clustering was performed on all nine of the composites.

A different clustering methodology was implemented, one designed to utilize the correlation structure in its algorithm. In addition, the determination of the number of Supply Groups per subpopulation was changed to be based on the subpopulation size. The FY86 supply population was used for this development.

As with the FY 84 supply population, the FY 86 supply exhibited high intercorrelations in its aptitude area composites (Tables A-11 and A-12). Ward's Minimum Variance Approach was chosen as the clustering algorithm to utilize this fact. This approach develops clusters by minimizing the within-cluster variability. It was used in conjunction with a nearest centroid sorting approach. The actual clustering (for each subpopulation) went as follows:

(1) Use a nearest centroid sorting routine (SAS procedure, FASTCLUS) to generate a large number (typically 100) of preliminary clusters. Using such a large number of clusters provided a better estimate of the wide range of different performance profiles.

(2) Remove those clusters which have a relatively small (less than 30) number of individuals. These clusters represent those small number of individuals who fall outside the more typical performance profiles. Since nearest centroid sorting algorithms are sensitive to "outlying" observations, they were removed and the algorithm was reapplied.

(3) Using the clusters from (2) as input to the nearest centroid sorting algorithm, regenerate another large set of clusters.

(4) Ward's Minimum Variance Algorithm was then applied to this last set of clusters to get the desired number of clusters (Supply Groups) for this subpopulation.

This approach generated 81 Supply Groups; Table A-13 lists these Supply Groups along with their average aptitude area composite scores. This formulation has been implemented in the current version of EPAS. Additional analyses are needed to evaluate alternative formulations and to determine how Supply Groups should be developed using the Project A measures.

Develop Supply Group Forecasts. The aggregate assignment model requires Supply Group forecasts on a RSM basis. The forecasting models and the USAREC mission goals provide mission based forecasts on a RSM basis. To get the required detail, the mission forecasts were multiplied by the population percentages for the Supply Groups. The percentages used were based on the year for which the Supply Groups were formulated.

TABLE A-9
FY84 SUPPLY GROUPS
BASED ON PRINCIPAL COMPONENTS

Male/NHS/AFQT Category I-II

Average Aptitude Area Composite Scores									% Mission
CL	CO	EL	FA	GM	MM	OF	SC	ST	
123	127	126	125	127	127	125	128	125	17.4
114	117	114	114	114	116	116	118	113	66.9
107	102	105	104	100	99	100	104	100	15.7

Male/NHS/AFQT Category IIIA

Average Aptitude Area Composite Scores									% Mission
CL	CO	EL	FA	GM	MM	OF	SC	ST	
108	117	112	110	116	118	115	118	112	33.5
103	105	103	102	102	105	105	106	101	63.9
97	87	96	92	88	82	78	88	84	2.6

Male/NHS/AFQT Category IIIB

Average Aptitude Area Composite Scores									% Mission
CL	CO	EL	FA	GM	MM	OF	SC	ST	
102	112	107	105	111	114	111	113	107	28.1
96	99	97	96	97	99	98	99	95	68.0
89	81	89	86	81	75	71	81	76	3.9

Male/NHS/AFQT Category IV

Average Aptitude Area Composite Scores									% Mission
CL	CO	EL	FA	GM	MM	OF	SC	ST	
90	106	97	97	106	109	103	104	98	14.4
86	93	89	89	92	95	91	91	87	70.2
84	82	83	85	79	81	78	79	76	15.4

TABLE A-9 (continued)
FY84 SUPPLY GROUPS
BASED ON PRINCIPAL COMPONENTS

Male/HSDG/AFQT Category I-II

Average Aptitude Area Composite Scores									% Mission
CL	CO	EL	FA	GM	MM	OF	SC	ST	
125	127	128	127	127	126	124	127	127	41.3
115	113	115	114	112	111	110	114	111	55.0
103	96	105	100	97	88	80	96	88	3.7

Male/HSDG/AFQT Category IIIA

Average Aptitude Area Composite Scores									% Mission
CL	CO	EL	FA	GM	MM	OF	SC	ST	
109	117	114	113	117	117	114	117	113	33.0
104	103	105	103	102	101	99	103	99	63.9
94	85	96	90	95	75	66	84	76	2.2

Male/HSDG/AFQT Category IIIB

Average Aptitude Area Composite Scores									% Mission
CL	CO	EL	FA	GM	MM	OF	SC	ST	
100	110	106	105	110	112	108	110	105	25.5
95	106	96	95	94	96	92	95	91	70.0
89	81	88	86	78	74	69	79	74	4.5

Male/HSDG/AFQT Category IV

Average Aptitude Area Composite Scores									% Mission
CL	CO	EL	FA	GM	MM	OF	SC	ST	
90	105	97	96	105	108	102	102	96	14.2
86	91	88	90	89	93	89	88	85	76.5
83	81	81	85	75	77	74	76	73	9.3

TABLE A-9 (continued)
FY84 SUPPLY GROUPS
BASED ON PRINCIPAL COMPONENTS

Male/HSSR/AFQT Category I-II

Average Aptitude Area Composite Scores									% Mission
CL	CO	EL	FA	GM	MM	OF	SC	ST	
123	124	125	125	124	122	121	124	125	34.4
114	110	116	113	110	106	101	111	106	58.6
103	96	107	101	98	88	76	95	86	7.0

Male/HSSR/AFQT Category IIIA

Average Aptitude Area Composite Scores									% Mission
CL	CO	EL	FA	GM	MM	OF	SC	ST	
110	115	114	113	116	115	112	115	113	34.4
105	102	107	104	102	99	94	102	98	60.0
95	86	100	93	89	79	67	85	78	5.6

Male/HSSR/AFQT Category IIIB

Average Aptitude Area Composite Scores									% Mission
CL	CO	EL	FA	GM	MM	OF	SC	ST	
101	109	106	105	110	111	107	109	106	23.5
96	96	98	97	96	96	92	96	93	67.2
91	82	92	88	83	76	70	82	77	9.3

Male/HSSR/AFQT Category IV

Average Aptitude Area Composite Scores									% Mission
CL	CO	EL	FA	GM	MM	OF	SC	ST	
92	105	98	97	105	107	103	103	99	17.7
91	93	93	93	92	92	88	92	88	65.1
91	81	93	88	82	72	64	80	74	17.2

TABLE A-9 (continued)
FY84 SUPPLY GROUPS
BASED ON PRINCIPAL COMPONENTS

Female/HSDG/AFQT Category I-II

Average Aptitude Area Composite Scores									% Mission
CL	CO	EL	FA	GM	MM	OF	SC	ST	
124	121	122	125	117	115	118	120	122	24.8
113	105	108	110	101	100	104	105	106	68.9
100	91	101	94	90	81	71	90	77	6.3

Female/HSDG/AFQT Category IIIA

Average Aptitude Area Composite Scores									% Mission
CL	CO	EL	FA	GM	MM	OF	SC	ST	
107	107	106	109	104	104	105	105	107	21.6
102	96	97	100	91	91	93	94	94	74.2
93	82	94	87	82	71	62	81	70	4.2

Female/HSDG/AFQT Category IIIB

Average Aptitude Area Composite Scores									% Mission
CL	CO	EL	FA	GM	MM	OF	SC	ST	
100	103	100	104	100	100	101	100	101	11.6
94	91	90	94	86	89	91	88	89	76.8
88	81	83	86	76	78	79	78	78	11.6

Female/HSDG/AFQT Category IV

Average Aptitude Area Composite Scores									% Mission
CL	CO	EL	FA	GM	MM	OF	SC	ST	
91	96	93	96	93	93	93	92	91	18.1
87	87	86	90	82	85	84	82	86	69.9
84	78	79	84	72	76	76	74	74	12.0

TABLE A-9 (continued)
FY84 SUPPLY GROUPS
BASED ON PRINCIPAL COMPONENTS

Female/HSSR/AFQT Category I-II

Average Aptitude Area Composite Scores									% Mission
CL	CO	EL	FA	GM	MM	OF	SC	ST	
122	115	117	121	111	108	112	114	118	26.2
109	102	108	107	99	94	91	101	95	65.7
95	89	99	91	89	79	66	88	71	8.1

Female/HSSR/AFQT Category IIIA

Average Aptitude Area Composite Scores									% Mission
CL	CO	EL	FA	GM	MM	OF	SC	ST	
108	106	106	110	101	101	102	103	104	28.9
102	95	100	99	91	88	87	94	90	63.0
94	84	97	88	83	71	59	83	68	8.1

Female/HSSR/AFQT Category IIIB

Average Aptitude Area Composite Scores									% Mission
CL	CO	EL	FA	GM	MM	OF	SC	ST	
103	104	103	106	100	99	99	101	101	21.6
99	94	95	98	90	90	90	92	92	61.2
91	84	90	89	82	78	74	81	76	17.2

Female/HSSR/AFQT Category IV

Average Aptitude Area Composite Scores									% Mission
CL	CO	EL	FA	GM	MM	OF	SC	ST	
92	86	90	91	79	74	69	83	76	100.0

TABLE A-10
FY86 SUPPLY GROUPS
BASED ON PRINCIPAL COMPONENTS

Male/NHS/AFQT Category I-II

Average Aptitude Area Composite Scores									% Mission
CL	CO	EL	FA	GM	MM	OF	SC	ST	
114	119	115	115	115	117	118	119	115	68.0
123	129	127	126	129	128	126	130	127	19.0
108	106	103	106	99	103	107	107	104	13.0

Male/NHS/AFQT Category IIIA

Average Aptitude Area Composite Scores									% Mission
CL	CO	EL	FA	GM	MM	OF	SC	ST	
109	120	114	112	118	120	117	120	114	27.0
103	109	103	104	104	109	109	110	104	65.0
98	95	92	95	87	93	98	96	92	8.0

Male/NHS/AFQT Category IIIB

Average Aptitude Area Composite Scores									% Mission
CL	CO	EL	FA	GM	MM	OF	SC	ST	
101	111	104	104	107	111	109	111	105	68.0
95	97	92	95	90	95	98	97	93	32.0

Male/NHS/AFQT Category IV

Average Aptitude Area Composite Scores									% Mission
CL	CO	EL	FA	GM	MM	OF	SC	ST	
87	95	90	90	94	97	95	93	89	100.0

TABLE A-10 (continued)
FY86 SUPPLY GROUPS
BASED ON PRINCIPAL COMPONENTS

Male/HSDG/AFQT Category I-II

Average Aptitude Area Composite Scores									% Mission
CL	CO	EL	FA	GM	MM	OF	SC	ST	
126	130	130	129	131	129	127	129	129	36.0
117	118	117	118	116	116	117	118	117	59.0
109	103	103	105	97	99	104	103	103	4.0

Male/HSDG/AFQT Category IIIA

Average Aptitude Area Composite Scores									% Mission
CL	CO	EL	FA	GM	MM	OF	SC	ST	
106	110	106	107	107	109	109	109	107	66.0
101	96	95	98	90	94	98	96	95	10.0
112	121	117	116	121	121	117	120	118	26.0

Male/HSDG/AFQT Category IIIB

Average Aptitude Area Composite Scores									% Mission
CL	CO	EL	FA	GM	MM	OF	SC	ST	
102	115	109	108	115	116	112	114	109	13.0
95	103	97	99	99	103	102	101	98	64.0
90	91	87	91	85	90	92	88	96	24.0

Male/HSDG/AFQT Category IV

Average Aptitude Area Composite Scores									% Mission
CL	CO	EL	FA	GM	MM	OF	SC	ST	
85	90	84	89	83	89	88	85	83	37.0
88	100	92	94	96	100	97	96	91	58.0
92	111	102	101	111	113	106	108	102	5.0

TABLE A-10 (continued)
FY86 SUPPLY GROUPS
BASED ON PRINCIPAL COMPONENTS

Male/HSSR/AFQT Category I-II

Average Aptitude Area Composite Scores									% Mission
CL	CO	EL	FA	GM	MM	OF	SC	ST	
117	116	117	117	115	114	115	117	118	66.0
110	103	104	106	98	99	105	103	104	7.0
126	127	129	128	129	126	125	127	128	27.0

Male/HSSR/AFQT Category IIIA

Average Aptitude Area Composite Scores									% Mission
CL	CO	EL	FA	GM	MM	OF	SC	ST	
106	108	106	107	106	107	108	108	107	66.0
113	119	117	116	120	118	116	119	118	26.0
101	95	95	98	90	94	98	95	95	8.0

Male/HSSR/AFQT Category IIIB

Average Aptitude Area Composite Scores									% Mission
CL	CO	EL	FA	GM	MM	OF	SC	ST	
100	108	104	104	108	109	107	107	106	50.0
93	95	92	94	92	95	96	93	93	50.0

Male/HSSR/AFQT Category IV

Average Aptitude Area Composite Scores									% Mission
CL	CO	EL	FA	GM	MM	OF	SC	ST	
89	96	91	93	92	96	94	93	91	62.0
87	83	84	86	81	81	84	82	84	17.0
92	107	98	99	106	109	105	105	100	21.0

TABLE A-10 (continued)
FY86 SUPPLY GROUPS
BASED ON PRINCIPAL COMPONENTS

Female/HSDG/AFQT Category I-II

Average Aptitude Area Composite Scores									% Mission
CL	CO	EL	FA	GM	MM	OF	SC	ST	
108	100	100	105	92	93	101	99	101	19.0
117	112	113	117	106	105	110	110	114	65.0
127	125	126	129	122	119	121	123	126	17.0

Female/HSDG/AFQT Category IIIA

Average Aptitude Area Composite Scores									% Mission
CL	CO	EL	FA	GM	MM	OF	SC	ST	
104	101	99	105	94	96	100	98	101	66.0
99	92	90	96	83	87	94	90	91	22.0
111	111	110	114	108	106	108	109	112	12.0

Female/HSDG/AFQT Category IIIB

Average Aptitude Area Composite Scores									% Mission
CL	CO	EL	FA	GM	MM	OF	SC	ST	
95	95	92	99	88	91	94	91	93	65.0
101	105	101	106	100	101	102	101	103	9.0
91	87	85	92	80	84	88	83	85	26.0

Female/HSDG/AFQT Category IV

Average Aptitude Area Composite Scores									% Mission
CL	CO	EL	FA	GM	MM	OF	SC	ST	
90	96	91	98	90	91	91	89	92	31.0
86	87	83	90	81	85	86	81	83	69.0

TABLE A-10 (continued)
FY86 SUPPLY GROUPS
BASED ON PRINCIPAL COMPONENTS

Female/HSSR/AFQT Category I-II

Average Aptitude Area Composite Scores									% Mission
CL	CO	EL	FA	GM	MM	OF	SC	ST	
123	117	120	124	113	110	114	115	121	44.0
113	104	106	110	98	98	104	103	107	56.0

Female/HSSR/AFQT Category IIIA

Average Aptitude Area Composite Scores									% Mission
CL	CO	EL	FA	GM	MM	OF	SC	ST	
104	97	98	103	92	92	98	95	99	76.0
110	108	108	112	104	103	105	105	111	24.0

Female/HSSR/AFQT Category IIIB

Average Aptitude Area Composite Scores									% Mission
CL	CO	EL	FA	GM	MM	OF	SC	ST	
96	90	90	96	84	87	90	86	89	53.0
101	102	100	104	97	97	100	99	103	47.0

Female/HSSR/AFQT Category IV

Average Aptitude Area Composite Scores									% Mission
CL	CO	EL	FA	GM	MM	OF	SC	ST	
93	89	90	93	86	88	89	86	89	100.0

TABLE A-11

FY86 CORRELATIONS OF APTITUDE AREA COMPOSITES FOR MALE, HIGH SCHOOL GRADUATES, IN AFQT CATEGORY I-II

	APTITUDE AREA								
APTITUDE AREA	CL	CO	EL	FA	GM	MM	OF	SC	ST
CL	1.0	.5	.8	.8	.6	.4	.4	.6	.8
CO		1.0	.6	.8	.7	.8	.8	.9	.6
EL			1.0	.7	.9	.7	.6	.7	.9
FA				1.0	.6	.6	.6	.6	.7
GM					1.0	.8	.7	.8	.8
MM						1.0	.9	.9	.6
OF							1.0	.9	.7
SC								1.0	.7
ST									1.0

TABLE A-12

FY86 CORRELATIONS OF APTITUDE AREA COMPOSITES FOR MALE, HIGH SCHOOL GRADUATES, IN AFQT CATEGORY IIIA

	APTITUDE AREA								
APTITUDE AREA	CL	CO	EL	FA	GM	MM	OF	SC	ST
CL	1.0	.3	.8	.7	.5	.1	.1	.4	.6
CO		1.0	.5	.7	.6	.8	.8	.8	.5
EL			1.0	.6	.9	.5	.3	.6	.8
FA				1.0	.4	.4	.3	.5	.5
GM					1.0	.8	.7	.8	.8
MM						1.0	.9	.8	.5
OF							1.0	.8	.5
SC								1.0	.7
ST									1.0

TABLE A-13
FY86 SUPPLY GROUPS
BASED ON WARD'S MINIMUM VARIANCE METHOD

Male/NHS/AFQT Category I-II

Average Aptitude Area Composite Scores									% Mission
CL	CO	EL	FA	GM	MM	OF	SC	ST	
113	117	114	113	113	115	117	118	114	55.0
121	128	125	123	126	127	125	128	124	31.0
109	107	104	108	99	103	107	107	105	14.0

Male/NHS/AFQT Category IIIA

Average Aptitude Area Composite Scores									% Mission
CL	CO	EL	FA	GM	MM	OF	SC	ST	
99	96	93	96	88	94	98	96	93	9.0
102	107	101	103	101	106	108	108	102	40.0
105	114	108	107	110	114	113	115	109	28.0
109	119	115	112	120	120	117	120	115	23.0

Male/NHS/AFQT Category IIIB

Average Aptitude Area Composite Scores									% Mission
CL	CO	EL	FA	GM	MM	OF	SC	ST	
99	107	100	101	102	106	106	106	101	100.0

Male/NHS/AFQT Category IV

Average Aptitude Area Composite Scores									% Mission
CL	CO	EL	FA	GM	MM	OF	SC	ST	
86	95	91	90	95	98	96	93	90	100.0

TABLE A-13 (continued)
FY86 SUPPLY GROUPS
BASED ON WARD'S MINIMUM VARIANCE METHOD

Male/HSDG/AFQT Category I-II

Average Aptitude Area Composite Scores									% Mission
CL	CO	EL	FA	GM	MM	OF	SC	ST	
109	102	103	105	97	99	104	103	103	4.0
116	109	111	114	105	104	107	108	111	5.0
109	114	104	110	103	110	114	113	107	3.0
122	113	119	121	112	106	109	112	118	4.0
115	111	115	111	114	112	113	113	115	6.0
108	118	108	111	111	118	119	118	109	4.0
119	119	117	120	114	114	116	119	118	7.0
111	126	111	117	113	123	123	123	112	4.0
125	122	124	127	119	116	118	121	125	7.0
130	135	135	134	138	135	132	134	133	9.0
128	124	131	128	128	121	120	124	129	7.0
123	128	124	127	124	124	124	126	124	6.0
119	123	120	121	121	122	121	122	120	6.0
113	118	118	112	121	122	120	121	117	6.0
124	114	128	119	124	115	114	118	124	2.0
129	130	132	131	132	127	126	129	131	7.0
117	127	122	120	126	128	126	128	122	8.0
123	131	128	127	131	132	129	130	127	5.0

Male/HSDG/AFQT Category IIIA

Average Aptitude Area Composite Scores									% Mission
CL	CO	EL	FA	GM	MM	OF	SC	ST	
100	95	94	97	89	93	98	95	95	7.0
109	102	102	109	94	95	98	99	101	5.0
103	109	99	107	98	105	107	106	100	10.0
117	126	124	122	129	125	120	125	123	4.0
115	115	118	118	116	112	110	114	116	10.0
103	98	103	98	102	101	102	101	102	7.0
109	121	115	113	120	122	119	120	115	16.0
111	105	111	110	106	102	103	105	110	7.0
101	110	102	101	106	111	112	111	104	10.0
106	108	112	102	116	113	111	112	112	8.0
105	116	106	110	109	115	115	114	108	17.0

TABLE A-13 (continued)
FY86 SUPPLY GROUPS
BASED ON WARD'S MINIMUM VARIANCE METHOD

Male/HSDG/AFQT Category IIIB

Average Aptitude Area Composite Scores									% Mission
CL	CO	EL	FA	GM	MM	OF	SC	ST	
109	110	115	113	115	109	104	108	112	2.0
104	119	110	111	116	118	113	116	110	6.0
90	87	88	87	87	89	91	88	89	9.0
103	104	106	104	108	104	103	104	108	4.0
99	99	102	100	101	99	98	99	101	8.0
87	90	80	90	76	87	90	85	80	4.0
97	92	99	95	96	92	92	92	96	6.0
101	112	100	110	98	105	103	104	98	3.0
92	96	89	98	85	92	92	89	87	11.0
94	104	97	95	105	108	107	106	101	8.0
91	113	96	100	104	115	112	109	98	5.0
88	96	87	89	91	99	99	95	89	6.0
94	104	92	102	91	100	100	99	93	11.0
90	100	93	91	98	104	103	100	94	6.0
97	111	106	100	116	117	113	113	108	4.0
98	111	102	104	107	111	108	109	102	6.0

Male/HSDG/AFQT Category IV

Average Aptitude Area Composite Scores									% Mission
CL	CO	EL	FA	GM	MM	OF	SC	ST	
89	105	95	97	102	106	101	101	95	29.0
86	89	85	80	83	88	87	84	83	34.0
86	97	88	92	81	97	95	93	89	37.0

TABLE A-13 (continued)
FY86 SUPPLY GROUPS
BASED ON WARD'S MINIMUM VARIANCE METHOD

Male/HSSR/AFQT Category I-II

Average Aptitude Area Composite Scores									% Mission
CL	CO	EL	FA	GM	MM	OF	SC	ST	
118	118	119	119	117	116	117	118	119	65.0
127	128	130	129	130	127	125	128	130	21.0
111	107	106	109	101	103	108	107	107	16.0

Male/HSSR/AFQT Category IIIA

Average Aptitude Area Composite Scores									% Mission
CL	CO	EL	FA	GM	MM	OF	SC	ST	
109	113	112	111	113	113	112	113	112	71.0
103	101	100	102	97	99	103	101	101	29.0

Male/HSSR/AFQT Category IIIB

Average Aptitude Area Composite Scores									% Mission
CL	CO	EL	FA	GM	MM	OF	SC	ST	
92	92	90	92	88	92	93	90	91	30.0
98	106	102	102	105	106	105	105	103	70.0

Male/HSSR/AFQT Category IV

Average Aptitude Area Composite Scores									% Mission
CL	CO	EL	FA	GM	MM	OF	SC	ST	
89	100	94	95	98	102	99	98	95	64.0
88	89	86	90	84	85	86	86	86	36.0

TABLE A-13 (continued)
FY86 SUPPLY GROUPS
BASED ON WARD'S MINIMUM VARIANCE METHOD

Female/HSDG/AFQT Category I-II

Average Aptitude Area Composite Scores									% Mission
CL	CO	EL	FA	GM	MM	OF	SC	ST	
112	106	105	111	98	99	105	105	106	32.0
125	121	124	126	118	115	117	119	124	31.0
117	113	113	117	107	106	111	111	114	29.0
108	96	98	102	89	90	98	96	99	8.0

Female/HSDG/AFQT Category IIIA

Average Aptitude Area Composite Scores									% Mission
CL	CO	EL	FA	GM	MM	OF	SC	ST	
104	100	98	104	93	95	100	98	100	44.0
100	92	92	97	85	87	94	91	92	27.0
108	108	106	111	103	104	106	105	108	28.0

Female/HSDG/AFQT Category IIIB

Average Aptitude Area Composite Scores									% Mission
CL	CO	EL	FA	GM	MM	OF	SC	ST	
93	87	89	92	84	85	89	85	89	39.0
94	97	89	99	85	91	94	90	91	39.0
100	101	99	105	96	97	98	96	100	22.0

Female/HSDG/AFQT Category IV

Average Aptitude Area Composite Scores									% Mission
CL	CO	EL	FA	GM	MM	OF	SC	ST	
88	90	86	93	84	87	88	84	86	100.0

TABLE A-13 (continued)
FY86 SUPPLY GROUPS
BASED ON WARD'S MINIMUM VARIANCE METHOD

Female/HSSR/AFQT Category I-II

Average Aptitude Area Composite Scores									% Mission
CL	CO	EL	FA	GM	MM	OF	SC	ST	
117	110	112	117	105	103	108	108	113	100.0

Female/HSSR/AFQT Category IIIA

Average Aptitude Area Composite Scores									% Mission
CL	CO	EL	FA	GM	MM	OF	SC	ST	
105	100	100	105	95	95	100	98	102	100.0

Female/HSSR/AFQT Category IIIB

Average Aptitude Area Composite Scores									% Mission
CL	CO	EL	FA	GM	MM	OF	SC	ST	
98	95	95	100	90	91	95	92	96	100.0

Female/HSSR/AFQT Category IV

Average Aptitude Area Composite Scores									% Mission
CL	CO	EL	FA	GM	MM	OF	SC	ST	
93	89	90	93	86	87	89	86	89	100.0

DETERMINE/PROJECT MOS REQUIREMENTS

It is also necessary to determine the projected personnel requirements (quality targets, restrictions, etc.) and training information (class size, dates, location, etc.) to generate a viable assignment plan.

This information, based on data from the Army Training Resource and Requirements System (ATTRS), is initially defined by MOS. As with supply forecasts, however, the MOS must be reduced to reduce the size of the assignment problem.

Two functional areas represent the analysis necessary to provide the required MOS training projections, namely:

(1) Determine/Provide MOS Clustering.

(2) Provide MOS Training Fill Information.

Determine/Provide MOS Clustering

As previously stated, the Army's non-prior service assignment problem has approximately 840,000,000 possible assignment combinations. Just as methodology was developed to aggregate the forecasted supply of contractees into Supply Groups, so must means be developed to aggregate the demand (i.e., jobs to be filled) information into groups, called MOS Clusters. Both categorizations are based on demographic and performance characteristics, since this supports the Army's person-job match assignment problem.

While various formulations were developed and implemented during the project, the number of Supply Groups and MOS Clusters never exceeded 81 and 59, respectively. Hence, the Army's assignment problem was reduced to 57,348 (81x59x12 months) possible assignments--a size reduction by a factor of 10,000. This enables the formulation of an assignment problem within the range of feasibility for present computer systems.

MOS Clustering Considerations. The goal was to cluster MOS into groups which would preserve those MOS characteristics that are important to the assignment process. The concept of clustering MOS is not new; indeed, the need to reduce the numbers of MOS which must be considered to carry out many Army force management objectives led to grouping MOS by career management fields (CMF) and by CMF occupational clusters.

CMF were initially examined to determine if they would meet EPAS's cluster requirements. Unfortunately, they were found to be too heterogeneous. For example, most CMFs group MOS that require recruits of substantially different aptitudes.

Analysis of the Army's recruiting process indicated that the Army uses qualifications based on gender, education level, AFQT Category, and aptitude area to determine MOS eligibility. For example, combat-ready

MOS can't accept women, other MOS accept only high school diploma graduates, and all MOS have at least one qualifying aptitude area composite score. Army targets are set on the number in AFQT Categories I-IIIA, IIIB, and IV at the MOS level.

The first requirement for MOS Clusters, therefore, must be to provide sufficient detail to enable the models to process these various goals and restrictions.

A second requirement was the MOS in the clusters should be functionally alike. Many recruits come to the MEPS knowing, basically, the type of work they want. Usually, these recruits are amenable to any job which is functionally similar to the type they have specified as desirable. In addition, the skills required to perform successfully in potential MOS matches will be similar for skills which are functionally similar. Having functionally similar MOS clusters, therefore, will aid the guidance counselor in identifying jobs for which the recruit will be both qualified and interested.

Recruit performance in MOS was also examined as a clustering criterion. Performance measures included aptitude area, first term attrition, and relative utility.

The following criteria were identified for clustering MOS:

(1) Similar performance (aptitude area) functions

(2) Same gender and education restrictions

(3) Similar quality targets

(4) Similar qualifying aptitude area scores

(5) Similar functionality

MOS Cluster Development. Three different formulations have been developed for EPAS. Two were done for FY84 MOS. The first used first term attrition; the second, realtive utility. The third, based on aptitude area, was done for FY86. Two phases are used in each of these formulations.

The first phase, which is basically the same for all formulations, uses the restrictions imposed by the Army's assignment process to develop a preliminary set of MOS Clusters. The criteria used included gender, education level, and AFQT Category. Table A-14 gives the resulting categories.

Functionality criteria were also used at this stage. Job categories for the MOS were derived directly from the Department of Defense's Occupational Conversion Manual. Table A-15 displays these categories.

TABLE A-14
MOS QUALIFICATION CATEGORIES

Gender	Education level	AFQT Category
M/F	HSG/NHS	I-IIIA
M/F	HSG/NHS	I-IIIB
M/F	HSG/NHS	I-IV
M/F	HSG	I-IIIB
M/F	HSG	I-IV
M	HSG/NHS	I-IIIA
M	HSG/NHS	I-IV
M	HSG	I-IV

TABLE A-15
DoD OCCUPATIONAL CODES

Code	DoD Occupational Area
0	Infantry, Gun Crews, Seamanship
1	Electronic Equipment Repairmen
2	Communications and Intelligence
3	Medical and Dental
4	Other Technical
5	Functional Support and Administrative
6	Electrical/Mechanical Repair
7	Craftsmen
8	Service and Supply

The second phase of the formulation is dependent on the method being used to differentiate within the first phase groups. A description of the second phase, by method, follows.

Attrition Clusters. Individuals with the same demographic characteristics can have different predicted attrition when assigned to different MOS. MOS-level attrition is primarily a function of gender and education, with male high school diploma graduates having the lowest attrition.

Predicted MOS-level attrition methodology described in Manganaris and Schmitz (1984) were used as the basic measure. This work developed MOS-specific attrition estimates as a function of gender, education level, AFQT Category, and MOS assignment. MOS-unique equations were developed for the 76 MOS that accounted for the majority of Army accessions. In addition, a generic MOS equation was developed to predict MOS attrition for other MOS using aptitude area composites and the qualifying score. For EPAS, the MOS-specific estimates are used where they applied and the generic estimates for the remaining MOS.

An execessive number of clusters resulted when attrition-based clusters were generated as a function of both AFQT Category and education level. To remedy this problem, clusters were generated only on the male, high school graduate attrition. With this revision, the within-cluster attrition rates for the other gender and education levels stayed approximately the same. This resulted in 56 MOS Clusters (see Schmitz, McWhite, and Moore, 1985).

Relative Utility Clusters. ARI's Project A developed MOS-level relative utility measures which incorporated subjective judgements of the "utility" of a soldier's contribution to the Army (Wise, 1985). The measure gives five levels of utility, corresponding to predicted performance in the 90, 70, 50, 30, and 10th percentiles.

These utility measures were developed for only 40 MOS. To obtain measures for the other MOS, two Army officers (from ODCSPER and the Soldier Support Center) were asked to assign a value to the remaining MOS. These measures since been developed for all MOS.

The MOS within the phase 1 clusters were then ordered by their 90th percentile measure of utility. Only this utility measure was used since it was highly correlated with the others. Additional clusters were formed by splitting the phase 1 clusters based on this utility measure. Cluster breaks were made where the measure differed by more than 10.

No mathematical clustering was necessary since the groups were distinct. This procedure generated over 70 clusters. Thus number was reduced by joining small clusters with larger ones on the basis of their DoD Occupational Area, resulting in 59 clusters (see Schmitz, McWhite, and Moore, 1985).

Aptitude Area Clusters. For FY86, MOS clusters were generated on the basis of aptitude area composite score. A slight variation on the first phase was used here: the DoD Occupational Area was not incorporated until the second phase. Therefore, the first phase clusters were based on gender, education level, and quality. Within each of these clusters, the MOS were ordered by qualifying aptitude area, qualifying cut score, and DoD Occupational Area. Based on these additional categories, 99 MOS Clusters were generated, significantly more than could be accepted.

GRC analysts reviewed the list of MOS Clusters and, with the aid of the job descriptions given by the Enlisted Career Management Fields and Military Occupational Specialities, reduced the 99 clusters to 58. The aptitude area distinction was preserved at the expense of the cut scores and DoD Occupational Area. A weighting factor, the number of accessions for the MOS in FY86, was used as a criterion for combining clusters. The goal was to combine only the relatively small size MOS. The resultant MOS Clusters are listed in Table A-16.

MOS Clustering Summary. Due to the size and complexity of the Army's assignment process, the 300 or so MOS were aggregated into approximately 60 categories (MOS Clusters). Three different approaches were implemented in EPAS. All three utilized the assignment constraints to generate a preliminary set of clusters. The primary difference among the three was the performance measure: first term attrition, relative utility, and aptitude area.

In the most recent version, the aptitude area clusters, expert opinion was used to arrive at the final set of clusters. Automating this process will be a crucial part in the future development of an operational mode for EPAS.

Provide MOS Training Fill Information

Having developed the MOS Clusters to be used for any given execution of EPAS, some means is required to provide the current MOS training status in the form required by the assignment model. This requires three major steps:

(1) The class seat information in ATRRS must be transformed as needed by the assignment models. Principally, this means information on the minimum, maximum, and optimal class size, adjusted to eliminate seats against which a contract has already been signed.

(2) The resulting class seat information must be aggregated into the appropriate MOS Clusters.

(3) The class seat information must be updated to represent the ongoing Person-Job Match (PJM) process, whether simulated or actual allocations.

This requirement was met by developing a sub-system called the Training Requirements Module (TRM). The TRM takes the information provided by ATRRS, the detailed assignment model (the ACM), and/or the current classification system (REQUEST) and generates the necessary information. This process is, essentially, a bookkeeping operation which is described in Appendix B.

TABLE A-16
FY86 MOS CLUSTERS
BASED ON APTITUDE AREA COMPOSITES

---------------------------------- CLUSTER= 1 ----------------------------------

MOS	JOBTITLE	GENDER	EDUCLEV	AFQTCAT	DODGRP	QUALAA	QUALCUT	FY86ACC
29E	COMMUNICAT-ELECT RADIO REP	M/F	HSG/NHS	I-IIIA	1	EL	110	425
29F	FIXED COMSEC EQUIP REP	M/F	HSG/NHS	I-IIIA	1	EL	110	194
29J	TELETYPEWRITER EQ REP	M/F	HSG/NHS	I-IIIA	1	EL	110	226
29V	STRAT MICROWAVE SYS REP	M/F	HSG/NHS	I-IIIA	1	EL	110	177
34H	ADSME REP	M/F	HSG/NHS	I-IIIA	1	EL	110	2
35C	AUTOMATIC TEST EQ REP	M/F	HSG/NHS	I-IIIA	1	EL	110	25
36L	ELECTRONIC SWITCHING REP	M/F	HSG/NHS	I-IIIA	6	EL	110	65

---------------------------------- CLUSTER= 2 ----------------------------------

MOS	JOBTITLE	GENDER	EDUCLEV	AFQTCAT	DODGRP	QUALAA	QUALCUT	FY86ACC
26C	WEAPONS SUPPORT RADAR REP	M/F	HSG/NHS	I-IIIA	1	EL	115	16
29S	FIELD COMSEC EQ REP	M/F	HSG/NHS	I-IIIA	1	EL	115	231

---------------------------------- CLUSTER= 3 ----------------------------------

MOS	JOBTITLE	GENDER	EDUCLEV	AFQTCAT	DODGRP	QUALAA	QUALCUT	FY86ACC
26Y	SATCOM EQUIPMENT REPAIRER	M/F	HSG/NHS	I-IIIA	1	EL	120	231
35H	CALIBRATION SPECIALIST	M/F	HSG/NHS	I-IIIA	1	EL	120	105

---------------------------------- CLUSTER= 4 ----------------------------------

MOS	JOBTITLE	GENDER	EDUCLEV	AFQTCAT	DODGRP	QUALAA	QUALCUT	FY86ACC
93D	AIR TRAFFIC SYSTEMS REP	M/F	HSG/NHS	I-IIIB	1	EL	105	99
24C	IMPROVED HAWK FIRING SEC MEC	M/F	HSG/NHS	I-IIIB	1	EL	110	62
24G	IMPROVED HAWK INFORMATIO MEC	M/F	HSG/NHS	I-IIIB	1	EL	110	79
24U	HERCULES ELECTRONIC MECH	M/F	HSG/NHS	I-IIIB	1	EL	110	18
34F	DSTE REPAIRER	M/F	HSG/NHS	I-IIIB	1	EL	110	13
34T	TACTICAL COMPUTER SYS REP	M/F	HSG/NHS	I-IIIB	1	EL	110	71

---------------------------------- CLUSTER= 5 ----------------------------------

MOS	JOBTITLE	GENDER	EDUCLEV	AFQTCAT	DODGRP	QUALAA	QUALCUT	FY86ACC
96H	AERIAL SENSOR SPEC	M/F	HSG/NHS	I-IIIB	2	SC	95	33
05D	EW/SIGNT EMITTER IDENTIF	M/F	HSG/NHS	I-IIIB	2	SC	100	35

TABLE A-16 (Continued)
FY86 MOS CLUSTERS
BASED ON APTITUDE AREA COMPOSITES

CLUSTER= 6

MOS	JOBTITLE	GENDER	EDUCLEV	AFQTCAT	DODGRP	QUALAA	QUALCUT	FY86ACC
05H	EW/SIGINT MORSE INTERCEP	M/F	HSG/NHS	I-IIIB	2	ST	95	310
05K	EW/SIGINT NON-MORSE INTE	M/F	HSG/NHS	I-IIIB	2	ST	95	234
96D	IMAGE INTERPRETER	M/F	HSG/NHS	I-IIIB	2	ST	95	92
97G	SIGNAL SECURITY SPECIALI	M/F	HSG/NHS	I-IIIB	2	ST	95	14
98G	EW/SIGINT VOICE INTERCEP	M/F	HSG/NHS	I-IIIB	2	ST	95	1142

CLUSTER= 7

MOS	JOBTITLE	GENDER	EDUCLEV	AFQTCAT	DODGRP	QUALAA	QUALCUT	FY86ACC
91P	X-RAY SPECIALIST	M/F	HSG/NHS	I-IIIB	3	ST	100	257
91R	VETERINARY FOOD INSP	M/F	HSG/NHS	I-IIIB	3	ST	100	200

CLUSTER= 8

MOS	JOBTITLE	GENDER	EDUCLEV	AFQTCAT	DODGRP	QUALAA	QUALCUT	FY86ACC
96F	PSYCHOLOGICAL OPS SPECIALIST	M/F	HSG/NHS	I-IIIB	2	ST	105	63
98C	EW/SIGINT ANALYST	M/F	HSG/NHS	I-IIIB	2	ST	105	364
98J	NONCOMM INTERCEPTOR	M/F	HSG/NHS	I-IIIB	2	ST	105	90
71Q	JOURNALIST	M/F	HSG/NHS	I-IIIB	5	ST	105	164
71R	BROADCAST JOURNALIST	M/F	HSG/NHS	I-IIIB	5	ST	105	31

CLUSTER= 9

MOS	JOBTITLE	GENDER	EDUCLEV	AFQTCAT	DODGRP	QUALAA	QUALCUT	FY86ACC
33P	EW/I STRAT REC SUBSYS REP	M/F	HSG/NHS	I-IIIB	1	ST	115	76
33Q	EW/I PROCESS STORAGE EQU	M/F	HSG/NHS	I-IIIB	1	ST	115	82
33R	EW/ INTERCEPT AVN SYS REP	M/F	HSG/NHS	I-IIIB	1	ST	115	76
33T	EW/I TAC SYS REP	M/F	HSG/NHS	I-IIIB	1	ST	115	105

CLUSTER=10

MOS	JOBTITLE	GENDER	EDUCLEV	AFQTCAT	DODGRP	QUALAA	QUALCUT	FY86ACC
76X	SUBSISTENCE SUPPLIER	M/F	HSG/NHS	I-IV	5	CL	85	201
76P	MATERIAL CONTROL/ACCTING	M/F	HSG/NHS	I-IV	5	CL	90	1253
76V	MAT STORAGE/HANDLING	M/F	HSG/NHS	I-IV	5	CL	90	2055
76W	PETRO SUPPLY SPEC	M/F	HSG/NHS	I-IV	8	CL	90	2356

TABLE A-16 (Continued)
FY86 MOS CLUSTERS
BASED ON APTITUDE AREA COMPOSITES

CLUSTER=11

MOS	JOBTITLE	GENDER	EDUCLEV	AFQTCAT	DODGRP	QUALAA	QUALCUT	FY86ACC
71G	PATIENT ADMIN SPEC	M/F	HSG/NHS	I-IV	3	CL	95	359
76J	MED SUPPLY SPEC	M/F	HSG/NHS	I-IV	3	CL	95	389
71L	ADMINISTRATIVE SPEC	M/F	HSG/NHS	I-IV	5	CL	95	4719
71M	CHAPEL ACTIVITIES SPEC	M/F	HSG/NHS	I-IV	5	CL	95	411
73C	FINANCE SPECIALIST	M/F	HSG/NHS	I-IV	5	CL	95	886
75B	PERSONNEL ADMIN SPEC	M/F	HSG/NHS	I-IV	5	CL	95	1510
75C	PERSONNEL MGMT SPEC	M/F	HSG/NHS	I-IV	5	CL	95	879
75D	PERSONNEL RECORDS SPEC	M/F	HSG/NHS	I-IV	5	CL	95	857
75E	PERSONNEL ACTIONS	M/F	HSG/NHS	I-IV	5	CL	95	476
76C	EQUIPMENT REC/PARTS SPEC	M/F	HSG/NHS	I-IV	5	CL	95	2173
76Y	UNIT SUPPLY SPEC	M/F	HSG/NHS	I-IV	5	CL	95	4048
71N	FLIGHT OPER SPEC	M/F	HSG/NHS	I-IV	5	CL	100	461

CLUSTER=12

MOS	JOBTITLE	GENDER	EDUCLEV	AFQTCAT	DODGRP	QUALAA	QUALCUT	FY86ACC
36C	WIRE SYSTEMS INSTALLER	M/F	HSG/NHS	I-IV	6	EL	90	969
21G	PERSHING ELECTRONICS MAT SP	M/F	HSG/NHS	I-IV	1	EL	95	115
24L	IMPROVED HAWK LAUNC/MAT REP	M/F	HSG/NHS	I-IV	1	EL	95	55
26H	AIR DEFENSE RADAR REPAIRER	M/F	HSG/NHS	I-IV	1	EL	95	14
27B	LAND COMBAT SUPPORT SYST	M/F	HSG/NHS	I-IV	1	EL	95	43
27E	TOW/DRAGON REPAIRER	M/F	HSG/NHS	I-IV	1	EL	95	208
27G	CHAPARRAL/REDEYE REPAIRER	M/F	HSG/NHS	I-IV	1	EL	95	48
31V	TACTICAL COMMUNICATIONS	M/F	HSG/NHS	I-IV	1	EL	95	2461
35E	SPECIAL ELECTRONIC DEVIC REP	M/F	HSG/NHS	I-IV	1	EL	95	90
35K	AVIONIC MECHANIC	M/F	HSG/NHS	I-IV	1	EL	95	296
41E	A-V EQUIPMENT REPAIR	M/F	HSG/NHS	I-IV	1	EL	95	2
45G	CONTROL SYSTEMS REP	M/F	HSG/NHS	I-IV	1	EL	95	45
26T	RADIO/TELEVISION SYSTEMS	M/F	HSG/NHS	I-IV	5	EL	95	37
27L	LANCE SYSTEM REPAIRER	M/F	HSG/NHS	I-IV	6	EL	95	15
27M	MLRS REPAIRER	M/F	HSG/NHS	I-IV	6	EL	95	48

CLUSTER=13

MOS	JOBTITLE	GENDER	EDUCLEV	AFQTCAT	DODGRP	QUALAA	QUALCUT	FY86ACC
26Q	TACTICAL SATELLITE/MICRO OP	M/F	HSG/NHS	I-IV	2	EL	95	426
31M	MULTICHANNEL COMMUNICATI OP	M/F	HSG/NHS	I-IV	2	EL	95	3084
31N	TACTICAL CIRCUIT CONTROLLER	M/F	HSG/NHS	I-IV	2	EL	95	119
93F	FLD ARTILLERY METEO CREW	M/F	HSG/NHS	I-IV	4	EL	95	79

TABLE A-16 (Continued)
FY86 MOS CLUSTERS
BASED ON APTITUDE AREA COMPOSITES

CLUSTER=14

MOS	JOBTITLE	GENDER	EDUCLEV	AFQTCAT	DODGRP	QUALAA	QUALCUT	FY86ACC
27F	VULCAN REPAIRER	M/F	HSG/NHS	I-IV	1	EL	100	43
29M	TACT SATEL/MICROWAVE REP	M/F	HSG/NHS	I-IV	1	EL	100	127
35L	AVIONIC COMMUNICATIONS EQ RE	M/F	HSG/NHS	I-IV	1	EL	100	165
35M	AVIONIC NAVIGATION AND FL RE	M/F	HSG/NHS	I-IV	1	EL	100	134
35R	AVIONIC SPECIAL EQUIPMENT RE	M/F	HSG/NHS	I-IV	1	EL	100	111
36M	WIRE SYSTEMS OPERATOR	M/F	HSG/NHS	I-IV	6	EL	100	419
55G	NUCLEAR WEAP MAINT SPEC	M/F	HSG/NHS	I-IV	6	EL	100	65

CLUSTER=15

MOS	JOBTITLE	GENDER	EDUCLEV	AFQTCAT	DODGRP	QUALAA	QUALCUT	FY86ACC
24E	IMPROVED HAWK FIRING CON MEC	M/F	HSG/NHS	I-IV	1	EL	105	20
32D	STATION TECHNICAL CONTRO	M/F	HSG/NHS	I-IV	1	EL	105	427
46N	PERSHING ELEC/MECH REP	M/F	HSG/NHS	I-IV	6	EL	105	34

CLUSTER=16

MOS	JOBTITLE	GENDER	EDUCLEV	AFQTCAT	DODGRP	QUALAA	QUALCUT	FY86ACC
21L	PERSHING ELECTRONICS REP	M/F	HSG/NHS	I-IV	1	EL	110	53
24H	IMPROVED HAWK FIRE CONTR RE	M/F	HSG/NHS	I-IV	1	EL	110	44
24J	IMPROVED HAWK PULSE RADAR RE	M/F	HSG/NHS	I-IV	1	EL	110	30
24K	IMPROVED HAWK CONT WAVE REP	M/F	HSG/NHS	I-IV	1	EL	110	42
26E	AERIAL SURVEILLANCE SENS	M/F	HSG/NHS	I-IV	1	EL	110	9
26F	AERIAL PHOTOACTIVE SENSO REP	M/F	HSG/NHS	I-IV	1	EL	110	1
26K	AERIAL EL WARN/DEF EQ REP	M/F	HSG/NHS	I-IV	1	EL	110	1
27N	FORWARD AREA ALERTING RAD RE	M/F	HSG/NHS	I-IV	1	EL	110	45
34L	FIELD ART DIG SYSTEMS REP	M/F	HSG/NHS	I-IV	1	EL	110	21
34Y	FIELD ARTILLERY COMPUTER	M/F	HSG/NHS	I-IV	1	EL	110	46
39B	AUTOMATIC TEST EQUIP OP	M/F	HSG/NHS	I-IV	2	EL	110	27
35G	BIOMEDICAL EQUIPMENT SPE	M/F	HSG/NHS	I-IV	3	EL	110	125

CLUSTER=17

MOS	JOBTITLE	GENDER	EDUCLEV	AFQTCAT	DODGRP	QUALAA	QUALCUT	FY86ACC
43M	FABRIC REPAIR SPEC	M/F	HSG/NHS	I-IV	7	GM	85	57
57E	LAUNDRY/BATH SPEC	M/F	HSG/NHS	I-IV	8	GM	85	131

TABLE A-16 (Continued)
FY86 MOS CLUSTERS
BASED ON APTITUDE AREA COMPOSITES

CLUSTER=18

MOS	JOBTITLE	GENDER	EDUCLEV	AFQTCAT	DODGRP	QUALAA	QUALCUT	FY86ACC
51M	FIREFIGHTER	M/F	HSG/NHS	I-IV	4	GM	90	110
57F	GRAVE REGISTRATION SPEC	M/F	HSG/NHS	I-IV	4	GM	90	77
43E	PARACHUTE RIGGER	M/F	HSG/NHS	I-IV	8	GM	90	390
57H	CARGO SPECIALIST	M/F	HSG/NHS	I-IV	8	GM	90	533

CLUSTER=19

MOS	JOBTITLE	GENDER	EDUCLEV	AFQTCAT	DODGRP	QUALAA	QUALCUT	FY86ACC
41J	OFFICE MACHINE REPAIRER	M/F	HSG/NHS	I-IV	6	GM	90	2
45B	SMALL ARMS REPAIR	M/F	HSG/NHS	I-IV	6	GM	90	214
41C	FIRE CONTROL INS REP	M/F	HSG/NHS	I-IV	6	GM	95	65
55B	AMMO SPECIALIST	M/F	HSG/NHS	I-IV	6	GM	95	809
68M	WEAPONS SYS REP	M/F	HSG/NHS	I-IV	6	GM	95	308

CLUSTER=20

MOS	JOBTITLE	GENDER	EDUCLEV	AFQTCAT	DODGRP	QUALAA	QUALCUT	FY86ACC
44B	METAL WORKER	M/F	HSG/NHS	I-IV	7	GM	90	469
51B	CARPENTER/MASON	M/F	HSG/NHS	I-IV	7	GM	90	666
51C	STRUCTURES SPEC	M/F	HSG/NHS	I-IV	7	GM	90	158
51N	WATER TREATMENT SPEC	M/F	HSG/NHS	I-IV	7	GM	90	180
62E	HEAVY EQ OPERATOR	M/F	HSG/NHS	I-IV	7	GM	90	613
62F	LIFT/LOAD EQ OPERATOR	M/F	HSG/NHS	I-IV	7	GM	90	163
62H	CONCRETE EQ OPERATOR	M/F	HSG/NHS	I-IV	7	GM	90	24
62J	GENERAL CONSTRUCTION	M/F	HSG/NHS	I-IV	7	GM	90	353
62G	QUARRYING SPECIALIST	M/F	HSG/NHS	I-IV	7	GM	95	33

CLUSTER=21

MOS	JOBTITLE	GENDER	EDUCLEV	AFQTCAT	DODGRP	QUALAA	QUALCUT	FY86ACC
42C	ORTHOTIC SPECIALIST	M/F	HSG/NHS	I-IV	3	GM	100	19
42D	DENTAL LAB SPEC	M/F	HSG/NHS	I-IV	3	GM	100	54
42E	OPTICAL LAB SPEC	M/F	HSG/NHS	I-IV	3	GM	100	29

TABLE A-16 (Continued)
FY86 MOS CLUSTERS
BASED ON APTITUDE AREA COMPOSITES

CLUSTER=22

MOS	JOBTITLE	GENDER	EDUCLEV	AFQTCAT	DODGRP	QUALAA	QUALCUT	FY86ACC
51G	MATERIALS QUALITY SPEC	M/F	HSG/NHS	I-IV	4	GM	100	24
41B	TOPOGRAPHIC INS REPR	M/F	HSG/NHS	I-IV	6	GM	100	15
45K	TANK TURRET REPAIRER	M/F	HSG/NHS	I-IV	6	GM	100	288
45L	ARTILLERY REPAIRER	M/F	HSG/NHS	I-IV	6	GM	100	123
52C	UTILITIES EQ REP	M/F	HSG/NHS	I-IV	6	GM	100	590
52D	GENERATOR EQ REPR	M/F	HSG/NHS	I-IV	6	GM	100	2080
52F	TURBINE ENG GEN REP	M/F	HSG/NHS	I-IV	6	GM	100	50
44E	MACHINIST	M/F	HSG/NHS	I-IV	7	GM	100	214

CLUSTER=23

MOS	JOBTITLE	GENDER	EDUCLEV	AFQTCAT	DODGRP	QUALAA	QUALCUT	FY86ACC
55D	EXPL ORD DISPOSAL	M/F	HSG/NHS	I-IV	4	GM	105	198

CLUSTER=24

MOS	JOBTITLE	GENDER	EDUCLEV	AFQTCAT	DODGRP	QUALAA	QUALCUT	FY86ACC
62B	CONSTRUCTION EQ REP	M/F	HSG/NHS	I-IV	6	MM	90	1060
63B	LIGHT WHEEL MECHANIC	M/F	HSG/NHS	I-IV	6	MM	90	4861
63H	TRACK VEHICLE REPAIR	M/F	HSG/NHS	I-IV	6	MM	90	720
63J	QUARTERMASTER REPR	M/F	HSG/NHS	I-IV	6	MM	90	490
63W	WHEEL VEH. REPAIR	M/F	HSG/NHS	I-IV	6	MM	90	1043

CLUSTER=25

MOS	JOBTITLE	GENDER	EDUCLEV	AFQTCAT	DODGRP	QUALAA	QUALCUT	FY86ACC
61B	WATERCRAFT OPERATOR	M/F	HSG/NHS	I-IV	0	MM	100	141

TABLE A-16 (Continued)
FY86 MOS CLUSTERS
BASED ON APTITUDE AREA COMPOSITES

CLUSTER=26

MOS	JOBTITLE	GENDER	EDUCLEV	AFQTCAT	DODGRP	QUALAA	QUALCUT	FY86ACC
68J	AIRCRAFT FIRE CONTROL	M/F	HSG/NHS	I-IV	6	MM	100	423
24T	PATRIOT SYSTEM MECHANIC	M/F	HSG/NHS	I-IV	6	MM	105	83
61C	WATERCRAFT ENGINEER	M/F	HSG/NHS	I-IV	6	MM	105	92
63G	FUEL SYSTEMS REPAIR	M/F	HSG/NHS	I-IV	6	MM	105	318
63S	HEAVY WHEEL MECHANIC	M/F	HSG/NHS	I-IV	6	MM	105	918
63Y	TRACK VEH MECHANIC	M/F	HSG/NHS	I-IV	6	MM	105	318
67G	AIRPLANE REPAIR	M/F	HSG/NHS	I-IV	6	MM	105	23
67H	OBSERVPLANE REPAIR	M/F	HSG/NHS	I-IV	6	MM	105	60
67N	UTIL CHOPPER REPAIR	M/F	HSG/NHS	I-IV	6	MM	105	722
67R	AH-64 ATTACK HELICOP REP	M/F	HSG/NHS	I-IV	6	MM	105	214
67S	SCOUT HELICOPTER REP	M/F	HSG/NHS	I-IV	6	MM	105	82
67T	TRANPORT CHOPPER REPAIR	M/F	HSG/NHS	I-IV	6	MM	105	665
67U	MEDIUM COPTER REPAIR	M/F	HSG/NHS	I-IV	6	MM	105	642
67V	OBS/SCOUT COPTER REP	M/F	HSG/NHS	I-IV	6	MM	105	934
67Y	ATTACK COPTER REP	M/F	HSG/NHS	I-IV	6	MM	105	656
68B	AIRCRAFT P-PLANT REP	M/F	HSG/NHS	I-IV	6	MM	105	355
68D	AIRCRAFT P-TRAIN REP	M/F	HSG/NHS	I-IV	6	MM	105	205
68F	AIRCRAFT ELECTRICIAN	M/F	HSG/NHS	I-IV	6	MM	105	235
68G	AIRCRAFT STRUCT REP	M/F	HSG/NHS	I-IV	6	MM	105	415
68H	PNEUDRAULICS REPAIR	M/F	HSG/NHS	I-IV	6	MM	105	43

CLUSTER=27

MOS	JOBTITLE	GENDER	EDUCLEV	AFQTCAT	DODGRP	QUALAA	QUALCUT	FY86ACC
64C	MOTOR TRANSPORT OPR	M/F	HSG/NHS	I-IV	8	OF	90	5252
94B	FOOD SERVICE SPEC	M/F	HSG/NHS	I-IV	8	OF	90	3910

CLUSTER=28

MOS	JOBTITLE	GENDER	EDUCLEV	AFQTCAT	DODGRP	QUALAA	QUALCUT	FY86ACC
15D	LANCE MISSILE CREW MEMBE	M/F	HSG/NHS	I-IV	0	OF	100	479
15E	PERSHING MISSILE CREW MEM	M/F	HSG/NHS	I-IV	0	OF	100	381
25L	AN/TSQ 73 AIR DEF ART OP/REP	M/F	HSG/NHS	I-IV	1	OF	100	16
16H	ADA OPERATIONS & INTELLI	M/F	HSG/NHS	I-IV	2	OF	100	383
16E	HAWK FIRE CONTROL CREW MEM	M/F	HSG/NHS	I-IV	4	OF	100	1

CLUSTER=29

MOS	JOBTITLE	GENDER	EDUCLEV	AFQTCAT	DODGRP	QUALAA	QUALCUT	FY86ACC
94F	HOSPITAL FOOD SRVC	M/F	HSG/NHS	I-IV	3	OF	100	244

TABLE A-16 (Continued)
FY86 MOS CLUSTERS
BASED ON APTITUDE AREA COMPOSITES

------------------------------------ CLUSTER=30 ------------------------------------

MOS	JOBTITLE	GENDER	EDUCLEV	AFQTCAT	DODGRP	QUALAA	QUALCUT	FY86ACC
31K	COMBAT SIGNALER	M/F	HSG/NHS	I-IV	2	SC	90	2585
72E	TELECOM CTR OPER	M/F	HSG/NHS	I-IV	2	SC	90	686
72G	AUTO DATA TELECTR OPR	M/F	HSG/NHS	I-IV	2	SC	90	989

------------------------------------ CLUSTER=31 ------------------------------------

MOS	JOBTITLE	GENDER	EDUCLEV	AFQTCAT	DODGRP	QUALAA	QUALCUT	FY86ACC
31C	SINGLE CHANNEL RADIO OPE	M/F	HSG/NHS	I-IV	2	SC	100	3295

------------------------------------ CLUSTER=32 ------------------------------------

MOS	JOBTITLE	GENDER	EDUCLEV	AFQTCAT	DODGRP	QUALAA	QUALCUT	FY86ACC
81C	CARTOGRAPHER	M/F	HSG/NHS	I-IV	4	ST	85	41
84C	MOTION PICTURE SPEC	M/F	HSG/NHS	I-IV	4	ST	85	1
83E	PHOTO LAYOUT SPEC	M/F	HSG/NHS	I-IV	7	ST	85	45
83F	PHOTOLITHOGRAPHER	M/F	HSG/NHS	I-IV	7	ST	85	87

------------------------------------ CLUSTER=33 ------------------------------------

MOS	JOBTITLE	GENDER	EDUCLEV	AFQTCAT	DODGRP	QUALAA	QUALCUT	FY86ACC
91A	MEDICAL SPECIALIST	M/F	HSG/NHS	I-IV	3	ST	95	7352
91D	OPERATING ROOM SPEC	M/F	HSG/NHS	I-IV	3	ST	95	415
91E	DENTAL SPECIALIST	M/F	HSG/NHS	I-IV	3	ST	95	458
91F	PSYCHIATRIC SPECIALIST	M/F	HSG/NHS	I-IV	3	ST	95	196
91H	ORTHOPEDIC SPECIALIST	M/F	HSG/NHS	I-IV	3	ST	95	59
91J	PHYSICAL THERAPY SPEC	M/F	HSG/NHS	I-IV	3	ST	95	50
91L	OCCUPATIONAL THERAPY SPE	M/F	HSG/NHS	I-IV	3	ST	95	31
91N	CARDIAC SPECIALIST	M/F	HSG/NHS	I-IV	3	ST	95	23
91Q	PHARMACY SPECIALIST	M/F	HSG/NHS	I-IV	3	ST	95	255
91S	ENVIR HEALTH SPEC	M/F	HSG/NHS	I-IV	3	ST	95	225
91T	ANIMAL CARE SPEC	M/F	HSG/NHS	I-IV	3	ST	95	114
91U	ENT SPECIALIST	M/F	HSG/NHS	I-IV	3	ST	95	77
91Y	EYE SPECIALIST	M/F	HSG/NHS	I-IV	3	ST	95	84
92B	MEDICAL LAB SPEC	M/F	HSG/NHS	I-IV	3	ST	95	583

TABLE A-16 (Continued)
FY86 MOS CLUSTERS
BASED ON APTITUDE AREA COMPOSITES

CLUSTER=34

MOS	JOBTITLE	GENDER	EDUCLEV	AFQTCAT	DODGRP	QUALAA	QUALCUT	FY86ACC
54E	NBC SPECIALIST	M/F	HSG/NHS	I-IV	4	ST	95	684
81B	TECH DRAFTING SPEC	M/F	HSG/NHS	I-IV	4	ST	95	86
82B	CONSTRUCTION SURVEYOR	M/F	HSG/NHS	I-IV	4	ST	95	39
82D	TOPOGRAPHIC SURVEYOR	M/F	HSG/NHS	I-IV	4	ST	95	38
84B	STILL PHOTO SPEC	M/F	HSG/NHS	I-IV	4	ST	95	103
92C	PETRO LAB SPECIALIST	M/F	HSG/NHS	I-IV	4	ST	95	34
93P	FLIGHT OPER COORD	M/F	HSG/NHS	I-IV	5	ST	95	480

CLUSTER=35

MOS	JOBTITLE	GENDER	EDUCLEV	AFQTCAT	DODGRP	QUALAA	QUALCUT	FY86ACC
93H	ATC TOWER OPERATOR	M/F	HSG/NHS	I-IV	2	ST	100	138
93J	ATC RADAR CONTROLLER	M/F	HSG/NHS	I-IV	2	ST	100	48

CLUSTER=36

MOS	JOBTITLE	GENDER	EDUCLEV	AFQTCAT	DODGRP	QUALAA	QUALCUT	FY86ACC
74D	COMPUTER/MACHINE OPR	M/F	HSG/NHS	I-IV	5	ST	100	423
74F	PROGRAMMER/ANALYST	M/F	HSG/NHS	I-IV	5	ST	100	348
03C	PHYSICAL ACTIVITIES SPEC	M/F	HSG/NHS	I-IV	5	ST	105	28
73D	ACCOUNTING SPECIALIST	M/F	HSG/NHS	I-IV	5	ST	105	174

CLUSTER=37

MOS	JOBTITLE	GENDER	EDUCLEV	AFQTCAT	DODGRP	QUALAA	QUALCUT	FY86ACC
95B	MILITARY POLICE	M/F	HSG/NHS	I-IV	8	ST	100	6266

CLUSTER=38

MOS	JOBTITLE	GENDER	EDUCLEV	AFQTCAT	DODGRP	QUALAA	QUALCUT	FY86ACC
97E	INTERROGATOR	M/F	HSG	I-IIIB	2	ST	95	329

CLUSTER=39

MOS	JOBTITLE	GENDER	EDUCLEV	AFQTCAT	DODGRP	QUALAA	QUALCUT	FY86ACC
96B	INTELLIGENCE ANALYST	M/F	HSG	I-IIIB	2	ST	105	379
91G	BEHAVIORAL SCIENCE SPEC	M/F	HSG	I-IIIB	3	ST	105	166

TABLE A-16 (Continued)
FY86 MOS CLUSTERS
BASED ON APTITUDE AREA COMPOSITES

CLUSTER=40

MOS	JOBTITLE	GENDER	EDUCLEV	AFQTCAT	DODGRP	QUALAA	QUALCUT	FY86ACC
75F	PERS INFOSYS MGMT SPEC	M/F	HSG	I-IV	5	CL	105	122
71D	LEGAL CLERK	M/F	HSG	I-IV	5	CL	110	634

CLUSTER=41

MOS	JOBTITLE	GENDER	EDUCLEV	AFQTCAT	DODGRP	QUALAA	QUALCUT	FY86ACC
29N	TELEPHONE CENTRAL OFF REP	M/F	HSG	I-IV	6	EL	100	339

CLUSTER=42

MOS	JOBTITLE	GENDER	EDUCLEV	AFQTCAT	DODGRP	QUALAA	QUALCUT	FY86ACC
81E	ILLUSTRATOR	M/F	HSG	I-IV	4	ST	95	131
84F	AUDIO/TV SPECIALIST	M/F	HSG	I-IV	4	ST	95	92

CLUSTER=43

MOS	JOBTITLE	GENDER	EDUCLEV	AFQTCAT	DODGRP	QUALAA	QUALCUT	FY86ACC
81Q	TERRAIN ANALYST	M/F	HSG	I-IV	4	ST	100	19
55R	AMMO STOCK CONTROL AND ACC SP	M/F	HSG	I-IV	5	ST	100	107
00J	CLUB MANAGER	M/F	HSG	I-IV	8	ST	110	16

CLUSTER=44

MOS	JOBTITLE	GENDER	EDUCLEV	AFQTCAT	DODGRP	QUALAA	QUALCUT	FY86ACC
96R	GROUND SURVEILLANCE RADA	M	HSG/NHS	I-IIIB	2	EL	85	64

CLUSTER=45

MOS	JOBTITLE	GENDER	EDUCLEV	AFQTCAT	DODGRP	QUALAA	QUALCUT	FY86ACC
24M	VULCAN SYSTEM MECHANIC	M	HSG/NHS	I-IIIB	1	EL	110	52
24N	CHAPARRAL SYSTEM MECHANIC	M	HSG/NHS	I-IIIB	1	EL	110	17

TABLE A-16 (Continued)
FY86 MOS CLUSTERS
BASED ON APTITUDE AREA COMPOSITES

----------------------------------- CLUSTER=46 --

MOS	JOBTITLE	GENDER	EDUCLEV	AFQTCAT	DODGRP	QUALAA	QUALCUT	FY86ACC
11X	INFANTRY (ACTIVE ARMY NE	M	HSG/NHS	I-IV	0	CO	90	19371
12B	COMBAT ENGINEER AIRBORNE	M	HSG/NHS	I-IV	0	CO	90	3591
12C	BRIDGE CREWMAN	M	HSG/NHS	I-IV	0	CO	90	634
12F	ENGINEER TRACKED VEHICLE	M	HSG/NHS	I-IV	0	CO	90	224
19E	M48-M60 ARMOR CREWMAN	M	HSG/NHS	I-IV	0	CO	90	2267
19K	ARMOR SPECIALIST	M	HSG/NHS	I-IV	0	CO	90	1693
19D	CALVARY SCOUT	M	HSG/NHS	I-IV	2	CO	90	2515
12E	ATOMIC DEMOLITION MUNITIONS SP	M	HSG/NHS	I-IV	0	CO	100	3

----------------------------------- CLUSTER=47 --

MOS	JOBTITLE	GENDER	EDUCLEV	AFQTCAT	DODGRP	QUALAA	QUALCUT	FY86ACC
51R	INTERIOR ELECTRICIAN	M	HSG/NHS	I-IV	7	EL	95	327
52G	TRANSMISSION/DISTRIB SPEC	M	HSG/NHS	I-IV	7	EL	95	56

----------------------------------- CLUSTER=48 --

MOS	JOBTITLE	GENDER	EDUCLEV	AFQTCAT	DODGRP	QUALAA	QUALCUT	FY86ACC
13B	CANNON CREWMAN AA COHORT	M	HSG/NHS	I-IV	0	FA	85	6252

----------------------------------- CLUSTER=49 --

MOS	JOBTITLE	GENDER	EDUCLEV	AFQTCAT	DODGRP	QUALAA	QUALCUT	FY86ACC
15J	MLRS/LANCE OPERATION/FIR	M	HSG/NHS	I-IV	0	FA	100	74
13F	FIRE SUPPORT SPECIALIST	M	HSG/NHS	I-IV	2	FA	100	1206

----------------------------------- CLUSTER=50 --

MOS	JOBTITLE	GENDER	EDUCLEV	AFQTCAT	DODGRP	QUALAA	QUALCUT	FY86ACC
51K	PLUMBER	M	HSG/NHS	I-IV	7	GM	90	159

----------------------------------- CLUSTER=51 --

MOS	JOBTITLE	GENDER	EDUCLEV	AFQTCAT	DODGRP	QUALAA	QUALCUT	FY86ACC
45T	M2/BRADLEY FV MECH	M	HSG/NHS	I-IV	6	GM	95	205
54C	SMOKE OPERATOR	M	HSG/NHS	I-IV	0	GM	100	282
45D	FIELDART TURRET MECH	M	HSG/NHS	I-IV	6	GM	100	115

TABLE A-16 (Continued)
FY86 MOS CLUSTERS
BASED ON APTITUDE AREA COMPOSITES

------------------------------------ CLUSTER=52 ------------------------------------

MOS	JOBTITLE	GENDER	EDUCLEV	AFQTCAT	DODGRP	QUALAA	QUALCUT	FY86ACC
45E	TANK TURRET MECHANIC	M	HSG/NHS	I-IV	6	MM	100	178
45N	M60A1 TANK TUR MECH	M	HSG/NHS	I-IV	6	MM	100	194
63E	ABRAMS TANK MECH	M	HSG/NHS	I-IV	6	MM	100	422
63N	M6 TANK SYS MECH	M	HSG/NHS	I-IV	6	MM	100	388

------------------------------------ CLUSTER=53 ------------------------------------

MOS	JOBTITLE	GENDER	EDUCLEV	AFQTCAT	DODGRP	QUALAA	QUALCUT	FY86ACC
63D	FIELD ART SYS MECH	M	HSG/NHS	I-IV	6	MM	105	323
63T	ITV/IFV/CFV MECH	M	HSG/NHS	I-IV	6	MM	105	907

------------------------------------ CLUSTER=54 ------------------------------------

MOS	JOBTITLE	GENDER	EDUCLEV	AFQTCAT	DODGRP	QUALAA	QUALCUT	FY86ACC
16S	MANPADS CREWMAN	M	HSG/NHS	I-IV	0	OF	90	725

------------------------------------ CLUSTER=55 ------------------------------------

MOS	JOBTITLE	GENDER	EDUCLEV	AFQTCAT	DODGRP	QUALAA	QUALCUT	FY86ACC
16P	ADA SHORT RANGE MISSILE	M	HSG/NHS	I-IV	0	OF	100	430
16R	ADA SHORT RANGE GUNNERY	M	HSG/NHS	I-IV	0	OF	100	538
16X	AIR CREWMEMBER	M	HSG/NHS	I-IV	0	OF	100	685
16J	DEFENSE ACQUISITION RADA	M	HSG/NHS	I-IV	2	OF	100	72

------------------------------------ CLUSTER=56 ------------------------------------

MOS	JOBTITLE	GENDER	EDUCLEV	AFQTCAT	DODGRP	QUALAA	QUALCUT	FY86ACC
13M	MULTIPLE LAUNCH ROCKET S	M	HSG/NHS	I-IV	0	OF	105	367

------------------------------------ CLUSTER=57 ------------------------------------

MOS	JOBTITLE	GENDER	EDUCLEV	AFQTCAT	DODGRP	QUALAA	QUALCUT	FY86ACC
13R	FIELD ARTILLERY FIREFIND OP	M	HSG/NHS	I-IV	2	SC	100	142
17B	FIELD ARTILLARY RADAR CREW	M	HSG/NHS	I-IV	2	SC	100	7

------------------------------------ CLUSTER=58 ------------------------------------

MOS	JOBTITLE	GENDER	EDUCLEV	AFQTCAT	DODGRP	QUALAA	QUALCUT	FY86ACC
13C	TACFIRE OPERATIONS SPECI	M	HSG/NHS	I-IV	2	ST	95	175
13E	CANNON FIRE DIRECTION SP	M	HSG/NHS	I-IV	2	ST	95	545
82C	FLD ARTILLERY SURVEYOR	M	HSG/NHS	I-IV	4	ST	95	365

GENERATE AGGREGATE ASSIGNMENTS

The aggregate assignment model provides the optimization capabilities necessary to achieve the goal of improving the classification and utilization of Army NPS recruits. To fully meet the desired applications of EPAS, this aggregate model has to be flexible enough to use as a planning subsystem to analyze Army policy, as well as provide guidance to the classification subsystem used in assigning applicants to specific MOS.

The goal of the effort was to model the Army recruit management process to allow individual classification actions which met the overall goals and missions of the Army. An optimization technique was determined to be necessary and appropriate for the model; only an optimization routine would have the capability to "balance" all of the individual classification actions against the goals, thus making the individual actions consistent with the Army's goals. Clear-cut objectives exist, e.g., the annual training requirement for MOS, monthly accession values, quality distribution goals. Assignment cost criteria also exist, e.g., ASVAB Aptitude Area Composite scores. Further, Project A is investigating new performance predictors.

There is ample precedent for using linear optimization to support this goal: Charnes and Cooper (1961) and Glover and Klingman (1975) describe successful industrial and government applications of optimization in manpower planning, distribution, and management. Holz and Wroth (1980) and Klingman and Mote (1983) describe Army applications of linear programming models with thousands of variables and constraints.

While such precedents indicated that linear optimization was clearly feasible, modeling the Army recruit management process introduced an order of magnitude above previous efforts. With 140,000 applicants being processed annually for roughly 6,000 MOS/training date combinations, EPAS is faced with on the order of 840 million possible solutions. (Even after steps to reduce problem size, described below, the model formulation is still larger than existing Army personnel planning systems, as shown in Table A-17.)

TABLE A-17
OPTIMIZATION PROBLEM SIZES

SYSTEM	CONSTRAINTS	VARIABLES
ELIM	2,000	5,000
MOSLS-M	3,000	6,000
MOSLS-T	8,000	50,000
EPAS	**5,000**	**150,000**

The principle issue, therefore, was the question of the type of optimization model which would best meet the needs of EPAS. High speed network algorithms, such as used in the Army's MOS Level System (MOSLS) model, have the inherent appeal of very rapid solution times for large problems. This speed, however, is achieved only at the expense of certain model capabilities. Some of the elements of a model of the Army recruit management process introduce "non-network" constraints. A network formulation, for example, can handle either gender or quality goals, but not both.

A general linear programming (LP) model would be capable of modeling the complex relationships between people and MOS assignments; but the resultant linear program would be prohibitively large and would take an excessive amount of computer time to solve.

GRC concluded that two different modeling approaches are appropriate in addressing the system's goals. In order to reduce the size of the problem, both approaches utilize aggregate supplies and demands as discussed earlier in this appendix. Also, both use the same assignment cost criteria. Discussions of cost criteria are found later in this appendix.

One model is a modified assignment network, using special structure techniques to incorporate various Army recruiting policies. This network model simplifies the recruit problem by not addressing multiple goals, thus avoiding non-network constraints. This simplification allows the incorporation of a time dimension (e.g., monthly increments) which provides the ability to manage the DEP program. The network model is the optimization technique used to generate the optimal guidance for the sequential allocation routines (both the ACM and REQUEST). Development of this model is complete, and is implemented in the current EPAS system.

A disadvantage of the network formulation is that, since it does not have a full description of all the system constraints, it is not possible to utilize the model to test the feasibility of some policy alternatives. The second model, a linear program formulation which incorporates additional (non-network) constraints, is being developed to remedy this disadvantage of the network formulation. Attempts to include the time dimension with the additional constraints, however, resulted in an excessive problem size. The linear program formulation is in the development stage.

Used together, these two models provide a complete policy analysis capability for the planning system. The basic feasibility of policy alternatives can be verified using the LP formulation and, once verified, the network formulation can be used to generate the optimal guidance based on the policy.

Formulation of the Models

The models which were developed must strive to simultaneously meet numerous, often times competing, requirements. These requirements are:

(1) Fill requirements: Both fiscal-year (encompassing only those months remaining in the current recruit year) and twelve-month (encompassing the entire planning horizon) class fill requirements must be met for every MOS in every month.

(2) MOS-specific restrictions: Gender and education restrictions must be enforced (e.g. females excluded from combat MOS).

(3) AFQT Category IV limitations: The maximum allowable number of AFQT Category IV assignments to a given MOS must not be exceeded, if feasible.

(4) AFQT Categories I-IIIA missions: The minimum level of quality personnel must be met for each MOS, if feasible.

(5) Delayed Entry Program (DEP) limitations: DEP policy for each demographic group must be enforced. Recruits are not permitted to remain in the DEP beyond their associated demographic group's maximum, neither may they DEP into months which, while less than the maximum, have been "closed" to that demographic group.

(6) Gender missions: The annual female mission must be met for each MOS, if feasible.

Due to the size and run-time restrictions discussed above, not all of the above constraints could be explicitly modeled in both model formulations. Monthly requirements were not modeled in the linear programming formulation, while gender requirements were not modeled in the network formulation.

With the linear programming formulation, the model runs using annual data, making enforcement of monthly requirements impossible. With the network formulation, gender requirements would have to be modeled as non-network constraints. However, both formulations still provide very useful results, and meet the aggregate assignment goal of an optimal allocation mapping of supply to demand.

Brief descriptions of the models follow; detailed discussions on the selected model formulations and the design decisions involved may be found in Appendix B.

The Network Model

The network formulation, called the Quality Allocation Model (QAM), is currently implemented in EPAS. It is the principal tool for generating policy analyses and optimal guidance for the detailed allocation routines.

The ARCNET program was selected for the EPAS networking algorithm. This algorithm, the proprietary product of Analysis, Research and Computation of Austin, Texas, was selected for several reasons:

- ARCNET has been demonstrated to be a state-of-the-art procedure, providing rapid and accurate solutions.

- The Army has had extensive, satisfactory experience with ARCNET and its predecessors.

- The Army currently has operational licensing for ARCNET on its FORECAST computer system. This will facilitate implementation of an operational EPAS.

Determine Targets, Constraints and Goals. The network is formulated by a preprocessor which defines the problem in a format recognizable by ARCNET. This preprocessor defines the model in accordance with the requirements defined above as follows:

MOS Requirements. Enforcement of both the twelve-month and fiscal-year MOS requirements is accomplished by using these requirements as lower bounds in the network formulation.

AFQT Category Requirements. The AFQT category requirements are also modeled as arc bounds. AFQT Categories I-IIIA requirements appear as lower bounds, while AFQT Category IV limits appear as upper bounds.

MOS Restrictions. Education and gender restrictions are included through flow restrictions. Prior to the start of an EPAS run, a program is executed to determine eligibility for a Supply Group's assignment to an MOS cluster. Since both Supply Groups and MOS clusters may be redefined by the user, and MOS restrictions may be changed (e.g. an MOS which previously disallowed females may now permit them), it is necessary to determine eligibility at the start of each new EPAS run.

Restrictions are used to build an eligibility matrix for each Supply Group and MOS Cluster combination. If a Supply Group is flagged as being ineligible for assignment to a certain MOS cluster, the network formulation will not contain an arc connecting the Supply Group to the MOS Cluster. Thus, no assignment recommendations violating will be made which violate the policy environment under which EPAS is operating.

DEP Limitations. Implementation of the DEP limits is also accomplished through flow restrictions. In the current system design, the user is requested to enter minimum and maximum allowable DEP length[2] in months for each individual demographic group (defined by gender, education, and AFQT category). The model's preprocessor will not generate arcs between a Supply Group and an MOS Cluster if the combination is prohibited by the current DEP policy.

Gender Missions. Modeling gender missions is not possible in the pure network design used in EPAS. Gender missions (i.e. specific goals by MOS) are not stated by AFQT category, whereas all remaining MOS missions are by AFQT category. Therefore, to incorporate the gender goal, a non-network set of constraints would have to be used. Although this is mathematically possible, the resultant model's solution time would be greatly increased, while the amount of additional information gained, relative to the cost of solving such a model, is slight.

Recommendation List for Use in Detailed Assignment. The principal objective of the network model is to support the detailed assignment process. Many factors preclude using the network solution to classify recruits. Individual qualifications and interests and the hour-by-hour availability of MOS preclude many recruits from accepting the MOS which the network optimal solution recommends for their supply group. These factors will necessitate detailed allocations which cannot match the optimal solution. Some means had to be developed which can communicate the optimal guidance of the network model so that it can influence the range of MOS offered by Army guidance counselors.

The EPAS approach is the use of "ordered lists" through which each supply group's alternative MOS assignments are communicated to the detailed allocation process. These time-specific recommendations are placed in order of increasing "reduced costs" (ARCNET User's Guide, 1980) of the supply group's assignment arcs. In the optimal solution of a linear programming minimization problem, this would correspond to listing the non-basic variables in increasing order of their "$z_j - c_j$" (using standard linear programming notation). Reduced costs are included in the optimization's solution file, and are used in determining the order of the lists of time-specific MOS recommendations for each supply group.

The reduced cost for an MOS/training date which is part of the optimal solution will have the value of zero. Some MOS/training dates, which are part of an alternate optimal solution, will also have a value of zero. As assignments deviate further from the optimal solution, the value of their associated reduced costs increase. The list of possible

2 A RUDEP policy is currently being implemented into the model formulation. When completed, the Army manager will be able to designate months between the maximum and minimum values in which no accessions from the demographic group are to be allowed.

assignments is sorted in ascending reduced cost order, with ties broken by DEP length. Recommendations with shorter DEP length move closer to the top of the list. The resulting sorted list of MOS/training date combinations, with their associated reduced cost, is passed to the detailed assignment process. Figure A-1 provides an empirical example of this process.

This scheme has intuitive appeal because it selects those alternative jobs which would cause the least deviation from the optimal solution. A strict interpretation, however, would suggest that using reduced cost in this manner is only valid for one substitution of a job. The number of recruits which could be assigned to that MOS using the reduced cost as a substitution cost cannot be known without resolving the network. Fortunately, there is considerable flexibility for the supply-limited, quality recruits. Furthermore, the solution is resolved frequently. This tends to maintain the system near optimal, since overfilling in one period will be compensated for in the next period.

Determine Assignment Cost Criteria. To generate optimum assignments, some means must be established by which alternative solutions can be compared. This is done in linear optimization procedures by identifying the "costs" associated with each of the possible combinations. The term "cost" in the context of linear optimization does not necessarily mean dollar cost. It refers, instead, to a utility measure (or "metric") by which options may be compared. These metrics must be compatible with the Supply Group/MOS Cluster aggregations being utilized by the network model, i.e., the metric must represent the average value of the measure for all individuals who compose a Supply Group if members of the Supply Group were to be assigned to MOS within a given MOS Cluster. Generation of these summary metric values is performed within EPAS by an ancillary procedure called the Metric Generation Module (MGM).

A design criteria for EPAS provisions of a "test bed" to be used in evaluating different measures. The MGM had to, therefore, provide analysts with a means to enter new measures and automatically regenerate metrics if the overall environment changes (e.g., if Supply Groups were redefined).

EPAS currently gives the user five options from which the optimization metric may be chosen. These are:

(1) Aptitude Area score.

(2) Predicted Skill Qualifications Test (SQT) score.

(3) Relative Worth of MOS Assignment.

(4) Predicted Attrition Behavior.

(5) Delayed Entry Program (DEP)/Attrition Costs.

STEP 1: ARCNET Optimal Solution:

NBR	SUPPLY GROUP	MOS CLUSTER	START DATE	FLOW	COST	REDUCED COST
1	10	C02	8603	100	250	0
2		C03	8602	50	100	0
3		C02	8604	0	250	0
4		C02	8605	0	250	15
5		C03	8604	0	100	15

Column Definitions:

NBR: A simply ordering number.

SUPPLY GROUP: Each Supply Group will have a separate list generated by the network. For simplicity, only one is shown here.

MOS CLUSTER / START DATE: Each cluster/date legal combination will have its solution included.

FLOW: The number of applicants from the Supply Group which were used. Only combinations which were part of the optimal solution will have flow. In the example above, only row numbers one and two are part of the optimal solution.

COST: This is the cost of the flow from a Supply Group to an MOS Cluster. The network algorithm uses the product of this value and the flow to determine its optimal solution.

REDUCED COST: This is the "$z_j - c_j$" value. Optimal flows (rows one and two) have a reduced cost of zero. Alternate optimal solutions, such as row three, have a reduced cost of zero with no associated flow. In other words, flow could be redirected to this combination without adversely affecting the optimal cost. Non-optimal solutions (rows four and five) have zero flow and non-zero reduced costs.

Figure A-1. Example of Reduced Cost Processing

STEP 2: Sorted Solutions:

NBR	SUPPLY GROUP	MOS CLUSTER	START DATE	FLOW	COST	REDUCED COST
2	10	C03	8602	50	100	0
1		C02	8603	100	250	0
3		C02	8604	0	250	0
5		C03	8604	0	100	15
4		C02	8605	0	250	15

The optimal solution is sorted in ascending reduced cost order, with ties broken by DEP length, i.e., the earliest classes are processed first. In this example, rows 1 and 2 and 4 and 5 have been flipped.

STEP 3: Compute Scores:

NBR	SUPPLY GROUP	MOS CLUSTER	START DATE	FLOW	COST	SCORE
2	10	C03	8602	50	100	1000
1		C02	8603	100	250	995
3		C02	8604	0	250	950
5		C03	8604	0	100	800
4		C02	8605	0	250	795

The reduced costs are next changed into scaled scores based on the range of the reduced costs in the possible combinations. These values are computed to retain the ordering associated with the reduced cost and DEP lengths.

Figure A-1 (continued). Example of Reduced Cost Processing

STEP 4: Expand MOS List:

NBR	SUPPLY GROUP	MOS	START DATE	SCORE
1	10	26Y	8602	1000
2		35H	8602	1000
3		26C	8603	995
4		29S	8603	995
5		26C	8604	950
6		29S	8604	950
7		26Y	8604	800
8		35H	8604	800
9		26C	8605	795
10		29S	8605	795

The individual MOS clusters are now expanded into their component MOS. The flow and cost columns are deleted as they are not used by the sequential classification routines. The resulting list of MOS/Start Date combinations, by Supply Group, with their associated scores are then written to a file for the classification routines.

Figure A-1 (continued). Example of Reduced Cost Processing

Aptitude Area Score. When using the Aptitude Area Score as the metric, the MGM determines the aptitude area with which an MOS is associated. The ASVAB composite score associated with that aptitude area is then used. EPAS computes the ASVAB aptitude area composite scores from the actual ASVAB subtest scores. This provides the user with the capability of redefining composite definition, renormalizing existing scores, etc.

Predicted SQT Scores. SQT scores are predicted based on work performed by Project A personnel (McLaughlin, et al, 1984). This work contains regression analysis on 67 unique MOS, predicting the SQT score as a function of the ASVAB subtest scores. GRC expanded upon these data to generate information for all of the entry level MOS to be simulated.

Relative MOS Utility. This metric, also derived from Project A analyses, is based on the assumption that equal relative performance in different MOS is not necessarily of equal utility to accomplishing the Army's mission. A recruit capable of performing in the 90^{th} percentile in both Infantryman (11B) and Audio-Visual Equipment Repairer (41E), for example, would be considered to be of more value to the Army if assigned to the Infantry specialty.

AIR developed relative utility measures (ranging from 0 to 100) for 40 MOS corresponding to job performance in one of five percentile ranges (90, 70, 50, 30, and 10). GRC expanded these data to the additional (approximately) 220 MOS by clustering the MOS by mission block and DoD Occupational Category.

Predicted Attrition. Predicted attrition, defines the probability of a recruit completing the initial term of enlistment given assignment to an MOS. Computations for this metric were based on an ARI Report by Manganaris and Schmitz which defines first term attrition as a function of demographic characteristics, education, and AFQT. MOS-specific equations were developed for 76 MOS; a generic equation was defined for the remaining MOS. GRC utilized the MOS-specific equations where they applied and the generic estimates for the remaining MOS.

DEP/Attrition Costs. The fifth metric is a combination of two metrics: dollar cost as a function of length of DEP and dollar cost associated with first term attrition.

The underlying methodology behind the MGM is a weighted mean. Records of actual personnel are read by the program; the characteristics of the individual's record are evaluated to determine the Supply Group with which the person is to be associated. Scores for each of the metrics are generated for all MOS, whether or not the individual is eligible for the MOS. Individuals are scored against MOS for which they are ineligible for two reasons:

(1) It provides flexibility for policy analysis. The user may wish to determine the impact of allowing personnel to enter previously closed MOS (for example: females in previously male-only skills, non-high school graduates in skills for which a high school diploma has been required.) If this is to be allowed, the system must have scores for these previously undefined combinations.

(2) Some personnel may, in fact, be assigned to MOS for which they are apparently ineligible. For example, non-high school graduates with exceptionally high AFQT scores might have been assigned to a MOS specifying high-school diploma required. When generating summary reports comparing actual to simulated allocations, the scores for such conditions must be available to the report generators.

The Linear Programming Model

The linear programming (LP) formulation, called the Aggregate Allocation Model (AAM), is still in development. The LP formulation is based on the network formulation and, therefore, shares most of the targets, constraints, costs, etc. described above.

In the network model, monthly quality goals are met, as are fiscal-year and twelve-month MOS requirements. Assignment recommendations for Supply Groups to MOS clusters in specific time periods are produced for use in detailed allocation. The "look ahead" capability of the network, where anticipated supplies are allocated judiciously, ensures that the best possible candidates fill the more difficult MOS seats in future months. Initially, the attempt was made to model the LP at the monthly level of detail as well. The resultant program were much too large to be solved in a reasonable amount of time.

In the LP model, annual MOS requirements are still met, as are annual quality requirements. Gender requirements are also enforced; this is not done in the network formulation. The allocation mapping is performed only at the Supply Group to MOS cluster level. The AAM ensures that recruits are allocated throughout the year such that all missions (MOS, quality, gender) are met while the overall performance of the recruit pool is maximized.

The mathematical representation of the LP formulation is shown in Figure A-2. Its objective is to minimize the total cost of all assignments, constrained to meet all requirements using the available recruit pool. In addition, the following demand constraints are included in the LP formulation:

(1) MOS Cluster Annual Missions. The summation of all recruits assigned to each MOS Cluster must meet or exceed the annual mission for each MOS Cluster.

MINIMIZE: $\sum_{\forall i} \sum_{\forall j} C_{ij} * X_{ij}$

where: X_{ij} is the number of recruits from Supply Group i assigned to MOS Cluster j

C_{ij} is the "cost" of assigning a recruit from Supply Group i to MOS Cluster j

SUBJECT TO:

$\sum_{\forall j} X_{ij}$ <= $SUPPLY_i$ for all Supply Groups i.

$\sum_{\forall i} X_{ij}$ >= $DEMAND_j$ for all MOS Clusters j

$\sum_{\substack{\forall i \\ female}} X_{ij}$ >= $FEMALE\_REQ_j$ for all MOS Clusters j

$\sum_{\substack{\forall i \\ female}} X_{ij}$ <= $FEMALE\_CAP_j$ for all MOS Clusters j

$\sum_{\substack{\forall i \\ AFQT\ I\text{-}IIIA}} X_{ij}$ >= $QUALITY_j$ for all MOS Cluster j

$\sum_{\substack{\forall i \\ AFQT\ IV}} X_{ij}$ <= $CATIV\_CAP_j$ for all MOS Clusters j

where:

$SUPPLY_i$	- Supply of Supply Group i recruits
$DEMAND_j$	- Demand for recruits in MOS Cluster j
$FEMALE\_REQ_j$	- Female mission for MOS Cluster j
$FEMALE\_CAP_j$	- Female limit for MOS Cluster j
$QUALITY_j$	- Quality goal for MOS Cluster j
$CATIV\_CAP_j$	- AFQT Category IV limit for MOS Cluster j

Figure A-2. Linear Programming Model Formulation

(2) Female Mission. The summation of all female recruits assigned to each MOS Cluster must meet or exceed the female annual mission, but must not exceed the female limitation for that MOS Cluster.

(3) Quality Targets. The summation of all quality (AFQT Category I-IIIA) recruits assigned to each MOS Cluster must meet or exceed the quality targets for each MOS Cluster.

(4) AFQT Category IV Limits. The summation of all AFQT Category IV recruits must not exceed the AFQT Category IV capacity for each MOS Cluster.

The analyst may select the stringency of the model's constraints to examine the effects of specific policy changes. Two parameters are provided for this purpose:

(1) Cut Score Requirement Flag. This flag indicates whether the average metric score of the Supply Group must meet the qualifying metric score for an MOS Cluster to be eligible for assignment. If "1" the cut score requirement is imposed; if "0," it is not.

(2) Demographic Constraint Flag. This flag may take on three values:

(a) "0" indicates only the cut score requirement is imposed. Gender and AFQT category goals/capacities are ignored.

(b) "1" indicates both the cut score and female requirements are imposed. The AFQT category goals/ capacities are ignored.

(c) "2" indicates all demand constraints are imposed.

The analyst may set these flags to any combination of values. For example, if "1" is selected for the Cut Score Requirement flag and "0" for the Demographic Constraint flag, the AAM would enforce the qualifying cut score requirement, but not the gender or quality requirements. However, the resultant solution could produce an assignment mapping which misses both quality and gender missions in some MOS Clusters.

The AAM is executed independent of EPAS. Further refinement of the model, as well as development of code to automate generation of the required data inputs, are necessary before the AAM can be implemented within EPAS. Likewise, a means of conveying the optimal strategy to the detailed allocation routines must be developed before the AAM can be used to provide classification guidance. Since all data are at the annual level, only a limited amount of information may be passed for classification purposes.

GENERATE DETAILED ASSIGNMENT

The restrictions on the optimization model discussed in the previous section could lead to long range assignments which, while feasible and optimal in an aggregate sense, would be unattainable in a detailed application. The final requirement in generating optimal assignments, therefore, is a detailed evaluation of assignments.

Supporting this requirement requires a detailed Person-Job Match (PJM) process which matches single individuals to specific MOS/class start date combinations. This requirement is met in EPAS through two processes, specifically:

- The Applicant Classification Module (ACM). This module provides the detailed PJM processing necessary to support the Headquarters Planning Subsystem simulation capability.

- The REQUEST Interface Module (RIM). This module provides the communications between EPAS and REQUEST, the Army's current PJM classification system.

The Applicant Classification Module

New recruits are processed in a sequential manner by the current reservation system (REQUEST). One applicant at a time is processed by the guidance counselors at the Military Entrance Processing Stations (MEPS). Automatic lock outs prevent a single seat being accidentally allocated to more than one recruit. The net effect is one applicant being processed to completion before the next applicant enters the system.

The ACM has been designed as a sequential processing system to emulate this process and provide a detailed allocation simulation capability. The ACM processes one individual at a time and evaluates that individual against all possible school seat openings. Since the individual's complete record is available, as well as requirements for specific MOS, the ACM has the ability to go into great detail in determining the best job for each individual.

The basic functions required to support the ACM's sequential processing and the means by which these functions are performed in the current implementation are discussed in Appendix B. The rest of this section describes the analysis which led to the current ACM formulation.

Identification and selection of the sequential classification methodology to be performed involved several functions. These are depicted graphically in Figure A-3 and are discussed below.

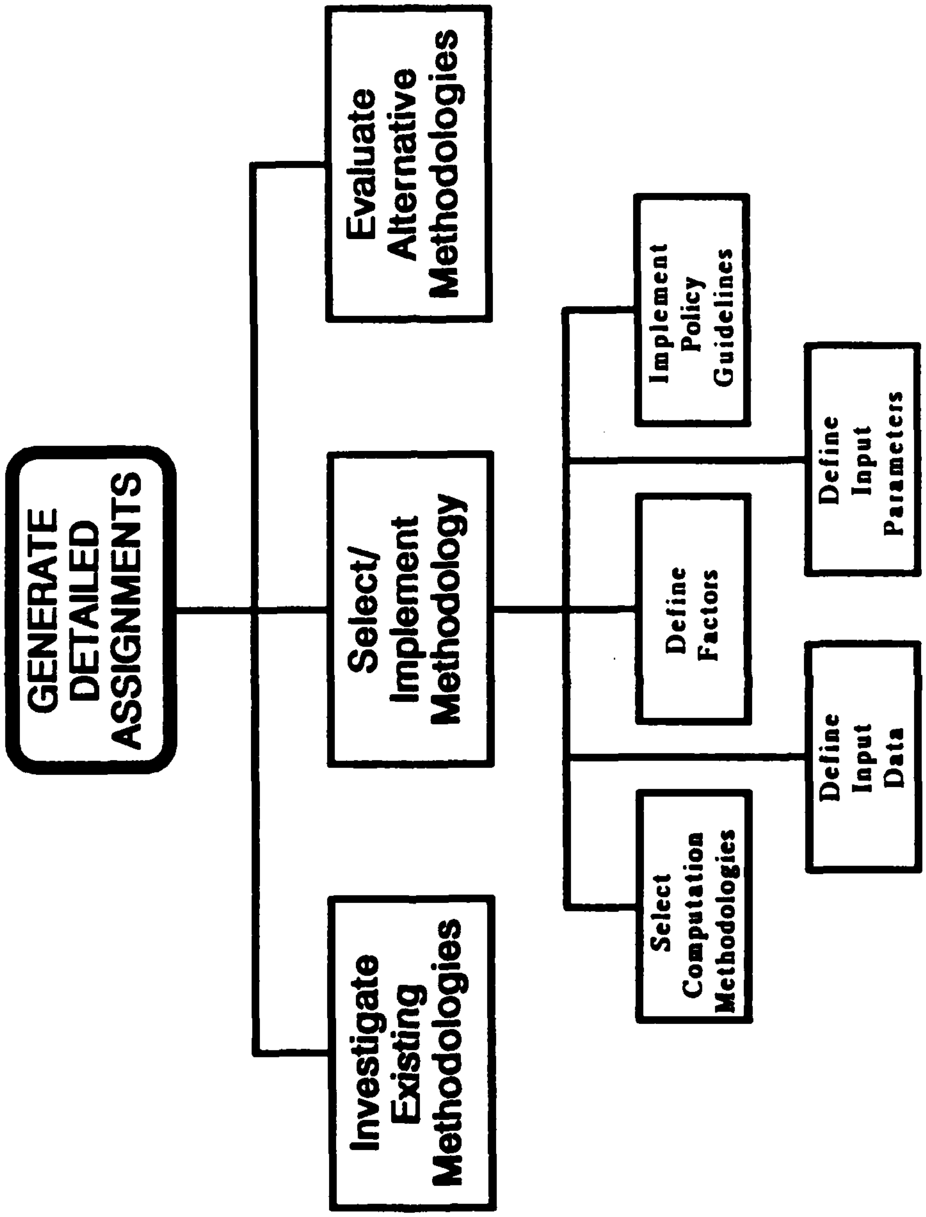


Figure A-3. Projecting Opimum Assignments

Investigate Existing Methodologies. The first task required by the EPAS Scope of Work (SOW) statement was an investigation and analysis of existing sequential classification methodologies.

All three of the branches of the Armed Forces use some form of sequential classification program to determine initial entry skills for their NPS recruits -- the Army uses the MOS Match Module (MMM); the Air Force, the Procurement Management Information System (PROMIS); and the Navy, the Classification and Assignment within PRIDE (CLASP) system.

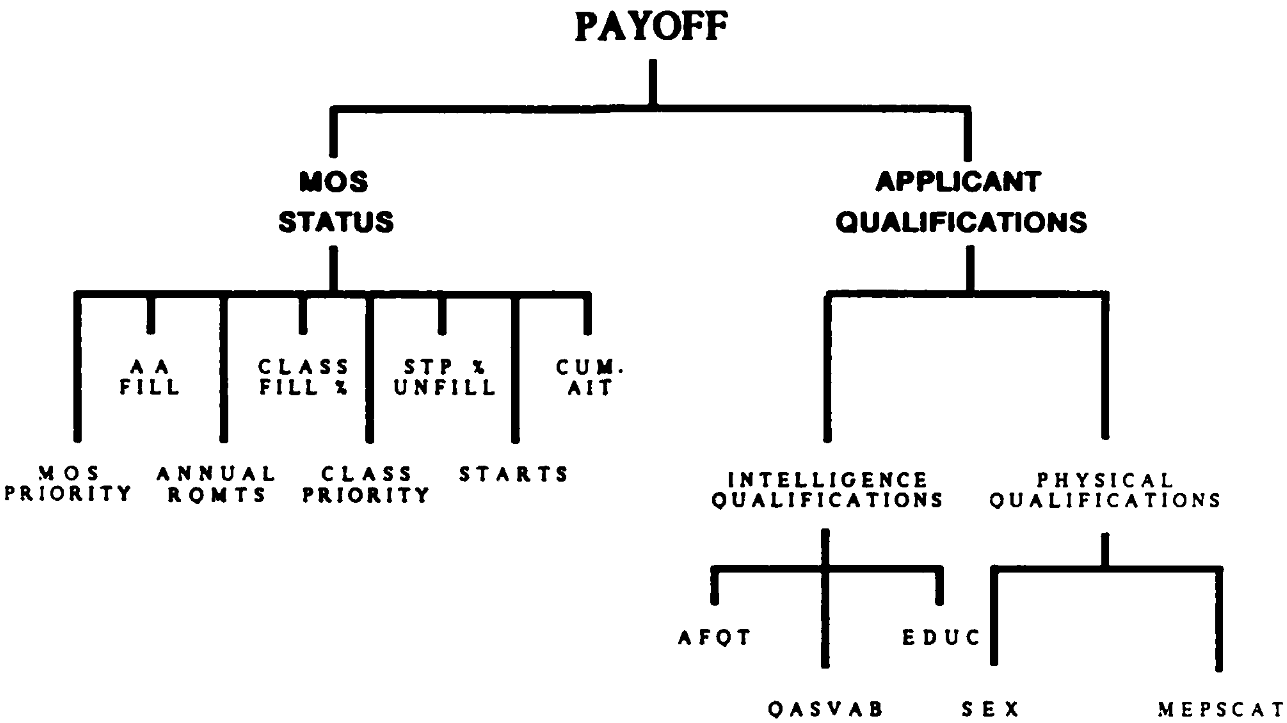
MOS Match Module (MMM). The structure of the Army's MMM system is depicted graphically in Figure A-4(a). The methodology employed in this system is that of straightforward linear weighting. Each of the factors depicted at the bottom of the figure is measured and transformed into a numerical score. Figure A-4(b) shows an example of a typical transformation function; in this example, the applicant's ASVAB Composite score (in the aptitude area with which the MOS is associated) is transformed. An ASVAB score of 100, for example, would be transformed into a score of 900.

The transformed score for each of the factors is multiplied by a corresponding weighting term define by the system's user. The results are then combined (summed) into two terms: one representing the current MOS Status, i.e., the Army's need to have the MOS filled immediately; the other representing the applicant's qualifications, i.e., how well the individual is qualified to perform the duties associated with the MOS. These two terms are then weighted and combined into a single value depicting the desirability of the PJM.

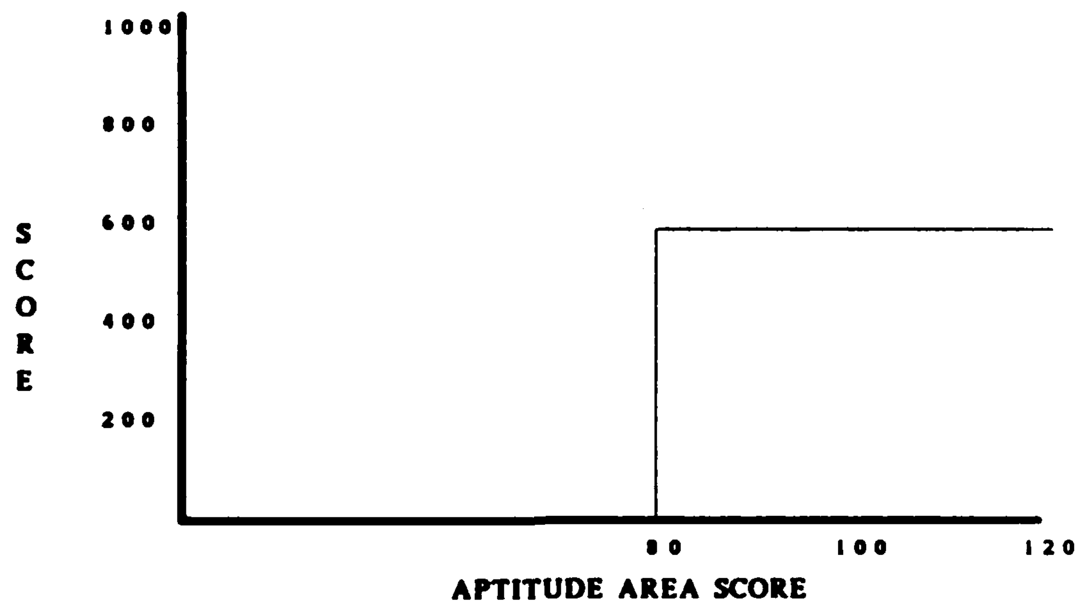
Procurement Management Information System (PROMIS). The structure of the Air Force's PROMIS system is depicted in Figure A-5(a). PROMIS is based on the concept of "Policy Specification" as described in Ward (1977). Basically, this concept states that qualified managers will be able to assess the relative "value" to the Air Force of differing combinations of two measures. The managerial assessments are input to a computer program which generates a mathematical equation to represent the relative values. Figure A-5(b) shows an example of a function which is generated by this process. The Aptitude/Difficulty and Fill%/ Time-to-Fill blocks in Figure A-5(a) are both generated using this technique.

The scores generated by policy specification are then combined with other factors using simple linear combinations as described for MMM.

Next, the generated scores are compared to an "Optimality Index". Optimality Indexes are generated for each of the Air Force's skills (AFSCs). The score from each individual/AFSC match is compared to the index for that AFSC and an adjusted score relative to the index is generated. This enables the Air Force to compare the individual against other individuals who can be expected to qualify for the AFSC and determine whether the current applicant is of the expected quality. Thus an individual who scores very high on a particular AFSC

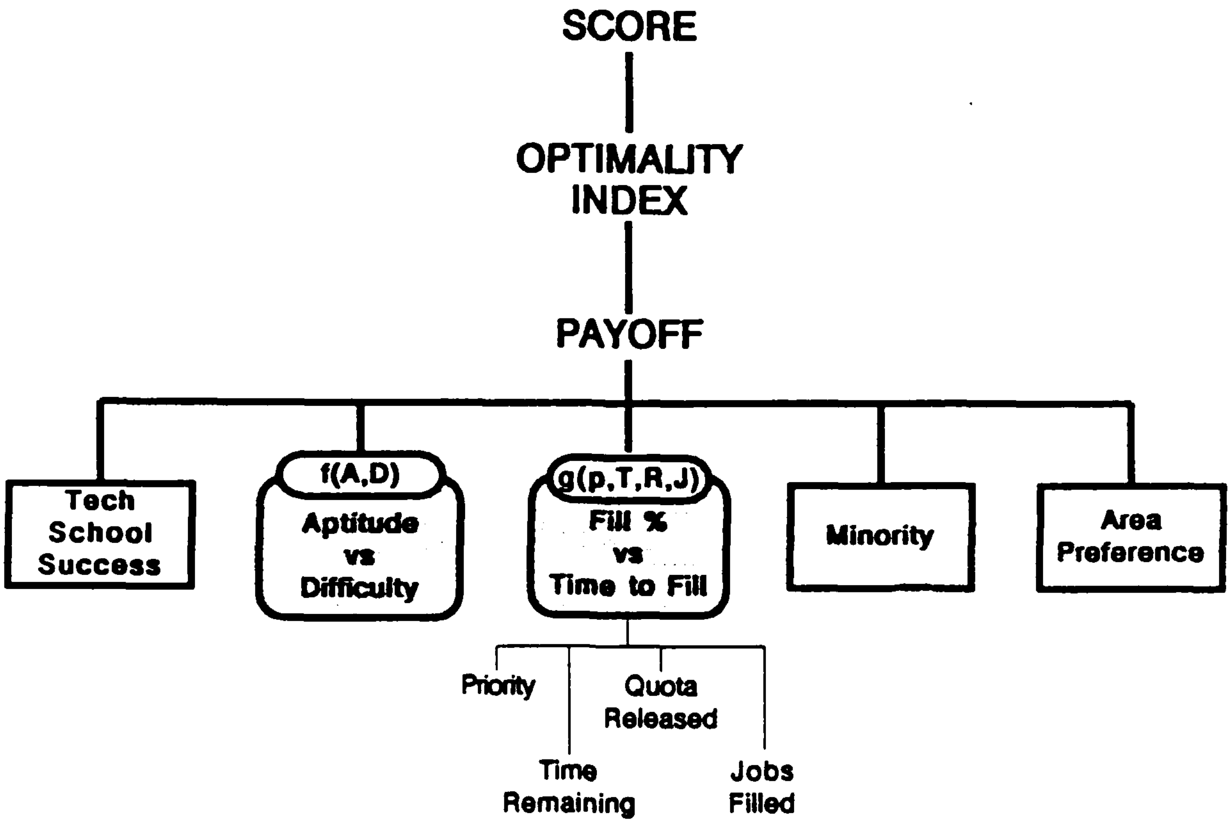


(a) Model Structure

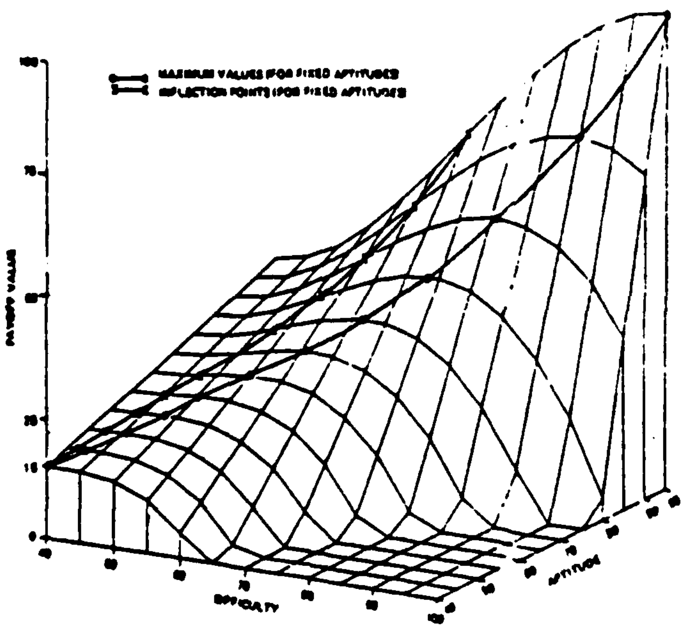


(b) Applicant Tranformation Table

Figure A-4. REQUEST MOS Hierarchy



(a) Model Structure



(b) Policy Specification Example

Figure A-5. Procurement Management Information System (PROMIS)

may in fact be lower than the expected quality and, therefore, be a poor fit for that skill; conversely, an individual may have an apparently low score for a AFSC, but be better than the expected average, thus being a good fit.

A complete description of the methodology behind PROMIS can be found in Hendrix, et al, (1979).

At the time GRC was performing its investigations, the Air Force was developing an enhanced version of the PROMIS system, depicted in Figure A-6. This version was being designed to utilize Policy Specification to define all of its interactions, thus the pair-wise structure shown in the figure.

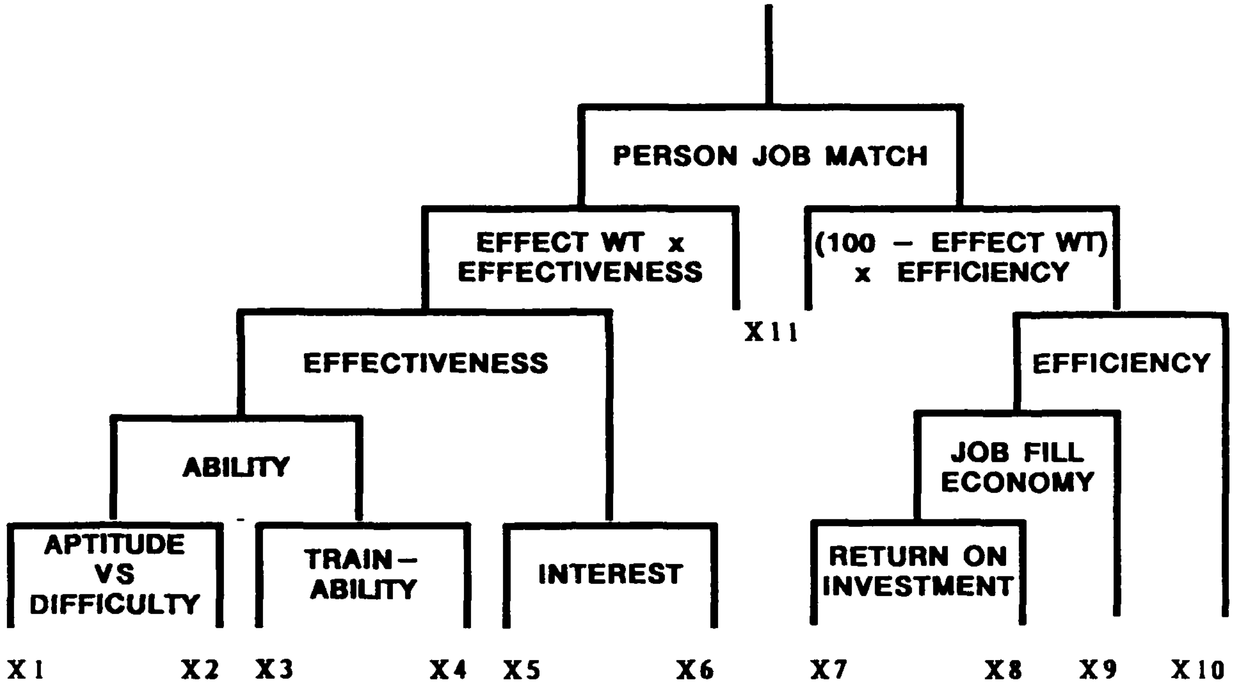
Classification and Assignment within PRIDE (CLASP). The Navy's CLASP system is depicted graphically in Figure A-7. As described in Kroeker and Rafacz (1983), CLASP was based on the Air Force's PROMIS system. The combination of Policy Specification and linear weighting described above was also used by the Navy with the specific factors tailored to Navy applications.

An additional feature incorporated into CLASP is the use of a limited simulation methodology to compute "Column Means" (CLASP's equivalent to PROMIS's Optimality Index). Actual accessions from the preceding year are iterated through the scoring routines. The resulting mean value is then used to adjust the computed score for future accessions.

Evaluate Alternative Methodologies. While each of these existing systems is unique, they all share an essentially common approach to the issue of classification and allocation. Specifically, they address one applicant at one point in time. PROMIS and CLASP attempt to evaluate applicants relative to others, but they do so in a non-optimal, historically-based manner.

Each of the classification systems claims to perform the "optimal" possible allocations of personnel. (See, for example, Kroeker and Rafacz (1983), page vii; Hendrix, et al, (1979), page 5; Kobbe MFR (1982).) In fact, however, each looks at a single applicant's record as that applicant enters the system. "Optimal" as used by the current systems refers only to the identification of the best job for the individual and the service at that particular point in time. None of the current systems generate solutions which, over time, generates the best solution.

This failure to generate the long-range, optimal assignment pattern led to the second requirement with short-range assignments, the evaluation of possible alternative methodologies for generating detailed assignments.



X1 -- Aptitude for the Job -- M, A, G, or E composite from ASVAB.

X2 -- Job Difficulty -- related to task difficulty from AFHRL and occupational measurement center surveys.

X3 -- Intellectual Ability -- predicted technical training school grade from ASVAB subtest scores.

X4 -- Academic Background -- percent of desireable high school courses completed

X5 -- Objective Interest -- VOICE score indicating relative interest in the job compared to all jobs.

X6 -- Restricted Interest -- ranking of the job compared to jobs available for the 12-16 DOT group.

X7 -- Training Cost -- from ATC cost factors and other manuals.

X8 -- Probability of Completing Term of Enlistment -- based on AFHRL research.

X9 -- Casual Time -- number of days between BMT graduation and technical training school entry.

X10 -- Fill Priority -- input at run time based on past fill rates, class frequency, class size, etc.

X11 -- Effectiveness Weight.

Figure A-6. Enhanced PROMIS Structure

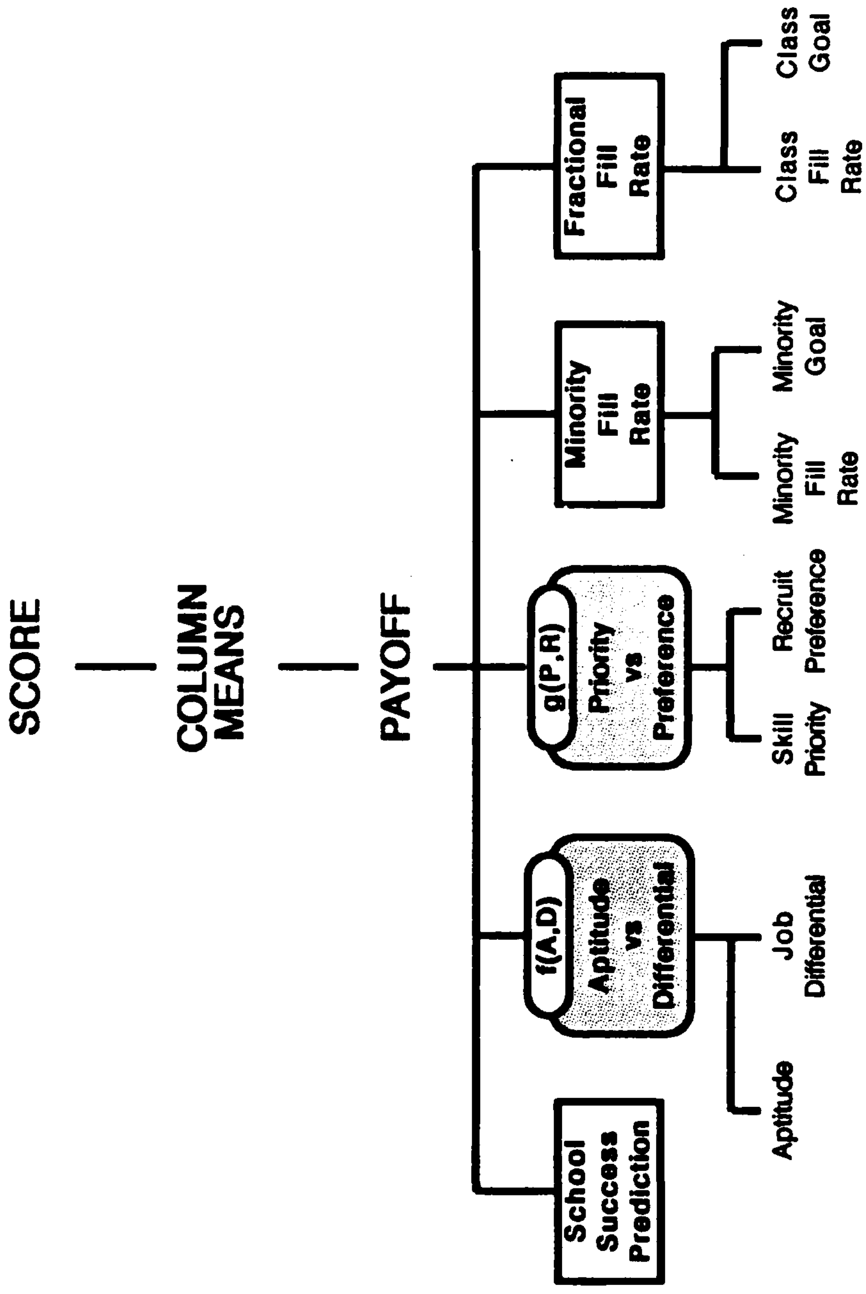


Figure A-7. Classification and Assignment within PRIDE

Utility Theory. It was apparent that any form of short-range assignment algorithm would have to deal with some kind of combinations of disparate measures. This led directly to the decision to evaluate "Utility Theory," a technique which specifically addresses this type of issue. Accordingly, a subcontract was issued to The Maxima Corporation to investigate the potential application of Utility Theory. The result of this study are reported in Stillwell (1983).

The results of this study were disappointing: utility theorists were wont to argue that, until some mathematically rigorous technique could be developed which related the disparate measures to a common scale, such combinations cannot be attempted. At its present state of development, Utility Theory was unable to offer appropriate techniques for measures as complex as those required and, therefore, it was argued, such combinations could not be performed.

Experience with existing classification systems has shown, however, that the measures can be meaningfully combined without developing such a mathematically rigorous technique. Experienced managers have repeatedly demonstrated the ability to adjust the parameters of classification systems so that the information obtained is meaningful and successfully meets the incumbent goals of the system.

Expert Systems. During visits to MEPS sites, GRC personnel were repeatedly impressed by the knowledge and capability of the Army's guidance counselors. This observation, plus GRC's experience in the development of Expert Systems, led to the concept of developing an Expert System which would automatically process applicants based on the expertise of guidance counselors. A second subcontract was let to Science Applications, Inc. to more thoroughly examine the process by which guidance counselors made their decisions. The results of this research are presented in Unger (1984).

The research indicated several promising areas of application, especially in support of recruiters and in preliminary processing of applicants for guidance counselors. It did not appear, however, that the Expert System approach was suitable to the classification function required by EPAS, particularly in view of the need to be able to evaluate the alternative predictors being developed by Project A. GRC recommended that the expert system not be the basis on which the short range assignments were generated.

Selection of Methodology. The third function required to support the projection of optimal assignments was to select a methodology to be utilized by EPAS, based on GRC's investigations of current and alternative methodologies. This function actually has three distinct parts. First, the methodology by which the payoff is to be computed must be determined. Second, the specific factors to be used as independent variables must be identified. Finally, determination of the means by which the ACM would ensure that the Army's various policy guidelines and MOS restrictions would be met as individual applicants were evaluated.

Determination of Methodology. The methodology chosen for the ACM comes not from a firm mathematical definition, but rather from the functional requirements of the system. The primary objective for EPAS is to provide the means by which new techniques for selection and classification could be evaluated and implemented. This objective requires that the resulting system provide the ability to quickly implement and clearly identify the relative impacts of new techniques. Complex functional interrelationships, such as developed with Policy Specification, would fail to meet the EPAS objectives on both counts: it would be difficult to include radically new measures into the functions, and the impact of the new measures would be masked by the functions.

Accordingly, the ACM's methodology was chosen to be a simple linear weighting of the selected measures. Individual measures could be defined and developed as "black boxes," that is, highly modularized mathematical definitions, with varying weights being applied to determine the impact of the measure in relationship with the other measures being used.

Selection of Measures. Similarly, the selection of measures to be implemented in the prototype ACM was performed based on the functional requirements of EPAS rather than a formal analysis. The EPAS requirement was to develop a computer system which could be used with externally defined measures. GRC, therefore, selected "typical" measures based on a survey of existing system, experience of knowledgable users, and the overall design philosophy of EPAS. The measures currently included in the ACM are:

(1) OAM Ordered List -- the optimal guidance generated by the aggregate assignment routines. This factor is unique to EPAS.

(2) Predicted Job Performance -- a detailed assessment of the individual's probable performance in an MOS. While only one option can be selected for inclusion in the scoring routines, the other predictors are computed and are available for the report generators. The available options are:

    (a) Aptitude Area Score. The applicant's ASVAB Composite Score for the aptitude area to which the MOS belongs.

    (b) Predicted SQT Score. SQT scores are predicted as a function of the ASVAB subtest scores based on the analysis performed by McLaughlin, et al.

    (c) Relative MOS Utility. The relative utility of an MOS assignment, as described previously in the MGM section.

(d) Project A Composite Measure. This is a partially implemented measure based on the work being performed by Project A to develop novel means of MOS classification. The necessary test are not currently given to the general applicant population; therefore, only a specially defined test population can be used at this time.

(e) Project A TKS Score. This option is also based on the Project A research. It utilizes only the Technical Skill (TKS) measure rather than the composite of all the measures.

(3) Predicted Retention Behavior -- the individual's probability of completing the first term of enlistment in the subject MOS.

(4) Management Potential -- an assessment of the individual's promotion potential and probability of successfully assuming a leadership/management role.

(5) Affirmative Action/Equal Opportunity Missions -- the success with which AA/EO missions are being met.

(6) Reenlistment Potential -- the probability of the individual reenlisting for the career force.

(7) Probable Training Success -- the probability of the individual successfully completing the skill training associated with the MOS.

(8) Time to Fill -- identifies EPAS's flexibility in filling the remaining annual requirement for the MOS.

(9) Class Training Demand -- identifies EPAS's flexibility in filling a specific class for the MOS.

Application of Policy Guidelines. This function enables the ACM to address specific policy restrictions and guidelines on an case-by-case basis, insuring that each the general guidelines received from the optimization procedures can be applied to the specific individual.

Examination of historical accessions shows the difficulty in fulfilling all of the requirements established for MOS given the entry restrictions applicable to MOS. Examples of situations which arise include "ineligible" personnel in skills (AFQT Category IV in skills excluding such personnel), failing to meet quality targets, and shortfalls in annual programs. Simply stated, if there are not enough accessions to meet certain missions, the Army must do the best it can with what it has. (This problem of distribution of scarce resource is ideally suited to an optimization approach as is used by EPAS.)

The ACM treats these restrictions in two ways, representing the two types of problems involved: one technique is used with entry restrictions; the second technique is used with "soft" missions.

When dealing with entry restrictions, the ACM is rigorous in enforcing policy guidelines. When a potential MOS is identified, the ACM first checks the individual's qualifications against the stated minimum requirements for the MOS. Failure to meet any of the minimum qualifications will result in the person being identified as ineligible for the skill.

"Soft" missions are areas where the Army has specified desired missions, or targets, but the model has the flexibility to adjust actual achievements as required. An example of this is the percentage of an MOS's accessions to be filled by quality personnel. Rather than shortfall the annual program, the ACM will fill the training seats with otherwise qualified Category IIIB personnel (or Category IV if necessary). When and if this type of substitution occurs is a function of several factors such as time remaining to fill the skill, difficulty in filling the skill, etc.

The REQUEST Interface Module

The interface between EPAS and REQUEST is a critical requirement for successful implementation of a real-time capability. Tests of EPAS have demonstrated the feasibility of using optimization techniques to improve classification of NPS recruits and have developed the vehicle (the ordered list) by which the optimal solution may be communicated in a usable fashion to a sequential allocation process. If the results of this research are to be applied in a real-time setting, the means of communicating between the two systems must be developed and REQUEST must be modified in a manner which will allow it to utilize the EPAS guidance.

The REQUEST Interface Module (RIM) will provide the necessary communication procedures to pass the optimal guidance from the aggregate allocation routines to the Army's operational PJM system, REQUEST. Two techniques have been investigated as candidates for interfacing EPAS to REQUEST: establishing a new hierarchy factor and setting control switches.

Setting Control Switches

REQUEST uses a series of switches to precisely control which factors are to be used, which MOS are open, etc. One potential means of using EPAS optimization results to direct MMM, therefore, appeared to be the use of the EPAS guidance to automatically set the appropriate switches.

The advantage of this approach would be that it requires a minimum amount of modification to existing systems. The principle problem associated with this approach is identifying switches which actually would be able to perform the desired control.

Preliminary investigations indicated that the existing switches do not provide sufficient control to allow interfacing EPAS to REQUEST by this means. Since the REQUEST switches were designed for different requirements, a considerable amount of analysis will be required to identify and modify suitable switches for this purpose..

New Hierarchy Factor

The second approach investigated was inclusion of a new factor in the MMM hierarchy to reflect the EPAS direction.

The advantages of this approach are that it will directly influence the resulting job list as desired and that it closely follows the manner in which the ACM applies this factor. The significant disadvantage to this approach is that it will require definition of a new factor, with the associated weights, controls, and so on, for MMM.

Here again, investigations indicated that this approach would not be suitable. The MMM hierarchy only scores MOS which REQUEST identifies as appropriate. It is probable, given the differences in the design and development of the two systems, that the MOS identified by REQUEST would be different from those recommended by EPAS. If this were to occur, the EPAS recommendations would never be seen by the MMM scoring procedures, hence no guidance would be communicated.

Develop Methodology to find Interface Point with MMM

As just shown, initial investigations into these alternatives indicated that neither were likely to be suitable. The reason for this is the difference in the techniques used by the two systems to determine which MOS are to be presented to the applicant.

Because of the large number of MOS/start date combinations available to applicants, both EPAS and MMM utilize logic to reduce the number of combinations to actually be considered for an applicant. In EPAS, this reduction is based exclusively on the ordered list generated by the optimization routines. Obviously, MMM, which has no comparable component, utilizes a totally different methodology.

The Current System. A schematic of the process employed by REQUEST is given in Figure A-8. The first step in this process is the elimination of MOS for which the applicant is not qualified. REQUEST checks all MOS within a specific time "window" defined as the applicant's date of availability (DOA) plus some system-specified number of weeks.

The current system next expands the list of potential assignments by identifying all possible classes within the window for the MOS identified above. This expanded list is then cut back as follows:

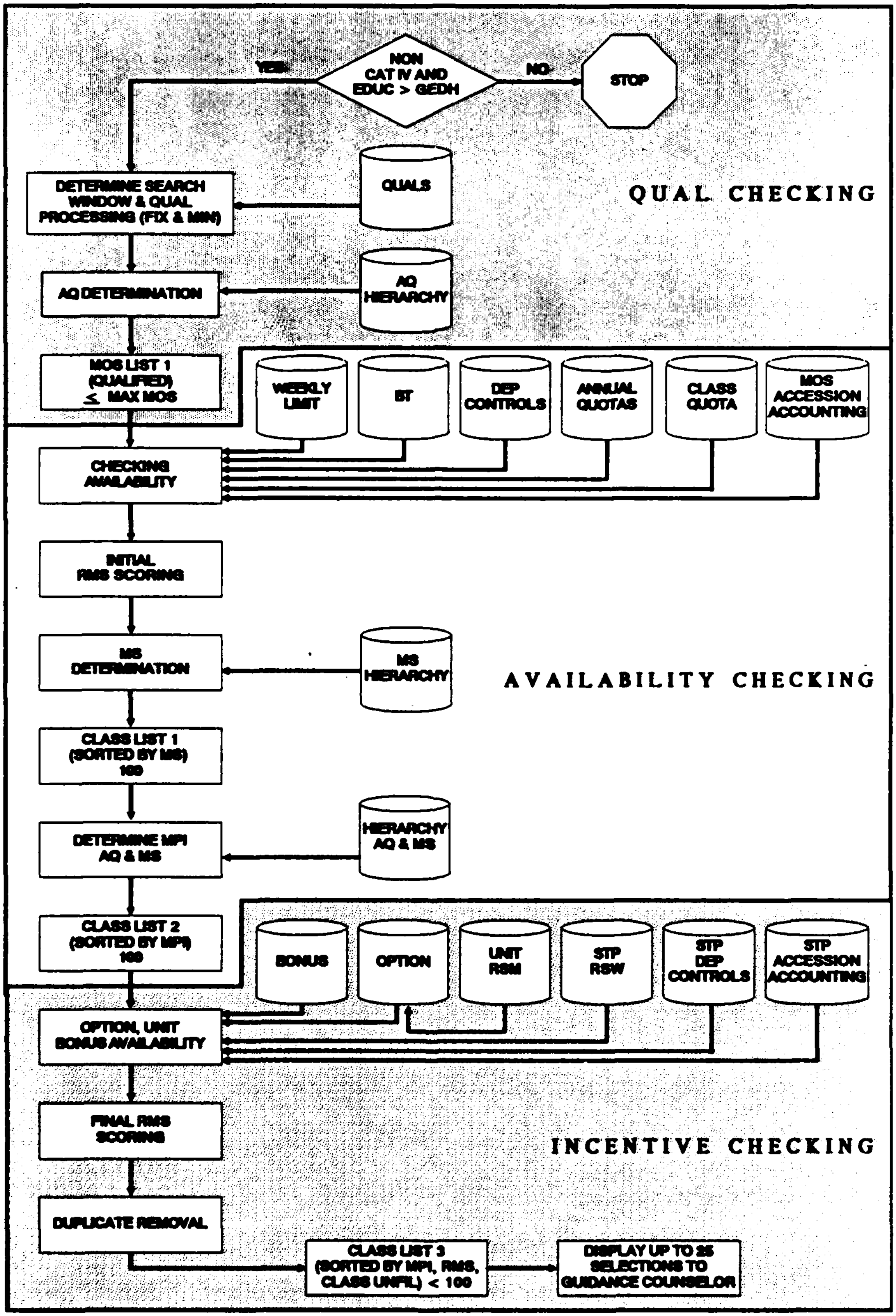


Figure A-8. REQUEST System's Search Procedure

(1) Each of the MOS/start dates in the expanded list is scored using the MOS hierarchy factors only.

(2) The expanded list is the sorted on the score generated in item (1).

(3) The 100 MOS/start date combinations with the highest scores are kept, all others are rejected.

Next, the applicant qualification side of the hierarchy is scored for the surviving 100 MOS/start date combinations. This score is linearly combined with the MOS hierarchy. This combination is effected with a 90% weight on the MOS hierarchy and a 10% weight on the applicant qualification. This dispraportionate weighting is necessary to insure the critical MOS within the window will be filled.

Several important facts need to be observed about this process. First, MOS which do not have classes beginning within the DOA-based window being examined will not be scored by this process. Thus, high priority or hard-to-fill skills may not be shown to eligible applicants. (Experienced guidance counselors can, and do, get around this limitation by "gaming" the system, i.e, they will change the DOA and rerun the search algorithm. At best, this is a hit-and-miss fix to the problem.)

Second, the selection of the final 100 MOS/start date combinations to be examined is made <u>independently of the applicant's performance potential</u>. Thus, applicants may never be shown MOS for which they are exceptionally well qualified.

Third, when the applicant qualification (i.e., potential performance) is finally included in the scoring, it is given such a low weighting as to be virtually negligible. This will have a particularly adverse affect once the new performance predictors being developed by Project A are implemented.

<u>EPAS Variations</u>. EPAS detailed classification (in the ACM), on the other hand, examines only those MOS contained on the ordered list for the Supply Group with which the applicant is associated. The ordered list was generated without regard to when the training class begins (as long as the class falls within the policy-specified DEP limitations). Thus, any MOS which need fill will be processed.

The ordered list contains MOS/start date combinations which have been sorted based on the QAM-adjusted reduced cost. This value, and therefore the sorted list, was generated with the Army's policies, the MOS' requirements, and the applicant's predicted performance jointly taken into consideration.

Finally, the linear combination of the hiearchy factors to generate the final payoff value has two significant differences:

(1) A new factor, the QAM-generated ordered list score, is included. This factor, since the optimization routines

included need-to-fill and time in its computations, implicitly addresses the requirement to insure that critical MOS are filled.

(2) The weights used to combine the three components of the hierarchy -- MOS, applicant qualification, and QAM ordered list -- are more equitably distributed. Thus, the final payoff value is a much more representative presentation of the applicant's best PJM.

Both of the interface alternatives discussed above (i.e., new hierarchy factor and setting switches) apply to scoring MOS/start date after they have been selected. This would mean that use of either of these techniques would not provide the desired ability of having EPAS recommendations being used by the current system to determine which MOS/start date combinations provide the best overall PJM.

Research continues to identify the structure of the REQUEST Interface Module which will best communicate between the two systems and to determine the optimal manner for introducing EPAS' optimal into REQUEST's search routines. Joint research is required with the Army, GRC, and REQUEST contractor personnel to insure that this interface and subsequent implementation can be performed in a manner which insures the integrity of the existing operating environment while accepting the long-range, optimal guidance from EPAS.

EPAS SYSTEM FRAMEWORK

Early in this research, it was determined that EPAS had to be developed in a system framework and that its components should be tested and evaluated using a testbed. This would enable evaluation of interdependent methodologies in a controlled environment and would support test scenarios. This framework was first used to test and develop the initial prototype and has since evolved to encompass the user interface as well as the system controller. As shown in Figure A-9, five functional areas comprise establishing the system framework:

(1) Determine computer system and development language.

(2) Provide a user and developer interface.

(3) Investigate and select a development methodology.

(4) Provide execution control.

(5) Provide execution status monitoring.

The following subsections discuss each of these areas.

Determine Computer System and Development Language

During the proposal evaluation phase of this contract, the Government recommended, in an additional proposal information request letter (dated 19 April 1982), and GRC concurred, in using A Programming Language (APL) for the EPAS prototype. A Demonstration Laboratory Facility (DLF) was to be established on which to analyze and evaluate various EPAS-candidate methodologies. DLF computer support requirements included multi-user access, APL, graphics, word processing, 9-track tape processing, communication and about 500M bytes of disk storage. Based on an evaluation of several computer systems, the WICAT 150/160 system was selected together with the use of other computers (NIH).

After procuring the DLF hardware, APL was used to code emulations of the current classification systems used by the Army (MMM), Navy (CLASP) and Air Force (PROMIS). Analysis of the results of these emulations indicated that, while APL was well suited for small analytical test modules, it could not support the larger EPAS prototype system. This was primarily because it could support neither extensive data base manipulations nor user-interface development. The Pascal language was selected for future prototype development because it could support:

(1) Libraries of routines, allowing all developers a common base of utilities.

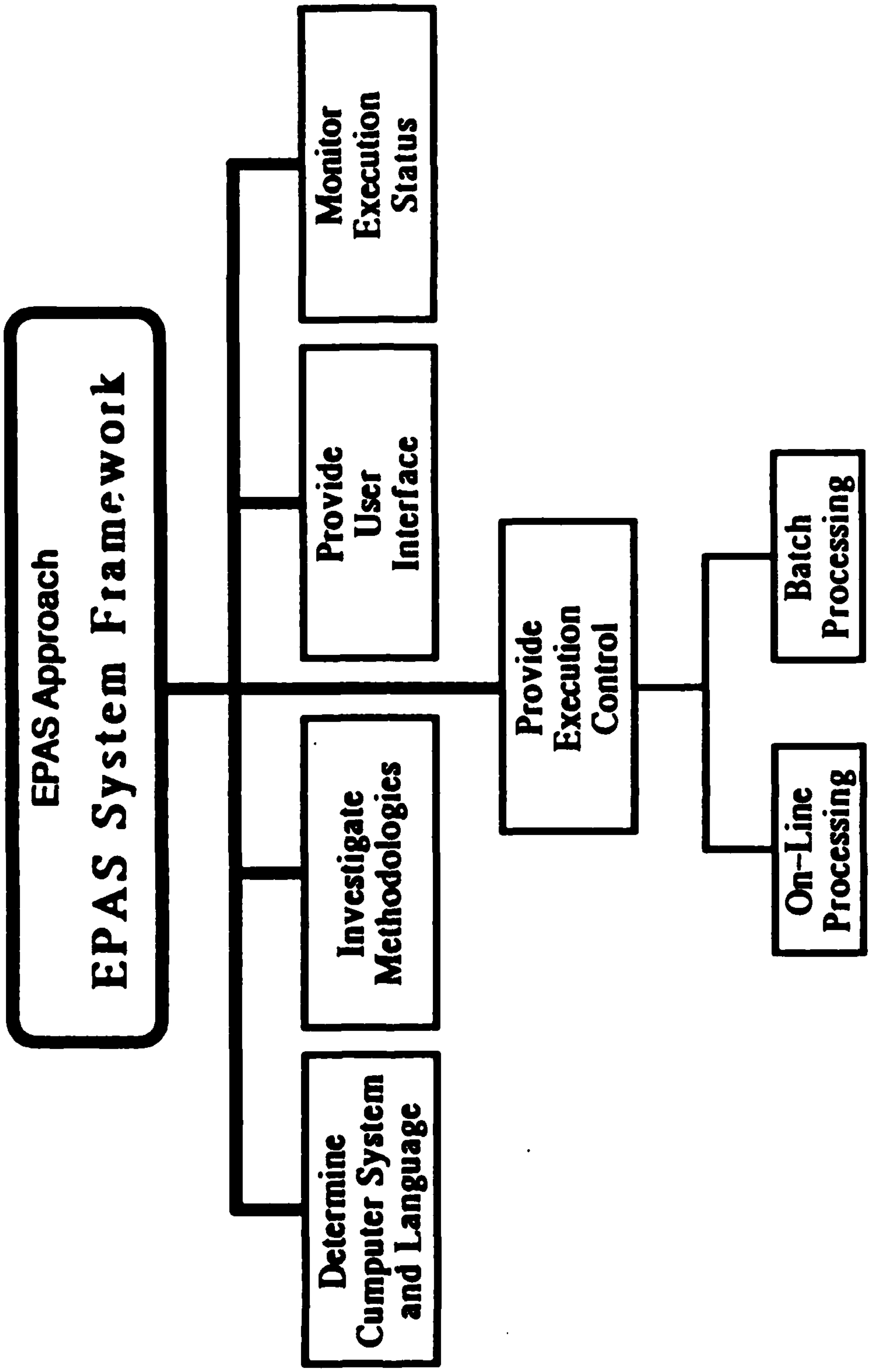


Figure A-9. EPAS System Framework

(2) Creation and deletion of the large external files needed for developing different scenarios.

(3) Sequential and index sequential file structures.

(4) Character and string manipulation.

(5) Direct access to many operating system utilities allowing more flexibility in developing screen displays.

(6) Structured coding allowing efficient development effort and less maintenance.

After development of the third prototype version of EPAS, the DLF was determined to be too slow to support Project A analyses. For example, a 12-month simulation using only 5,000 contractees required 4 days of wall-clock time. By comparison, tests of the EPAS optimization algorithm conducted on a mainframe indicated that a similar run could be completed in less than an hour. Several mainframe computers were investigated as potential candidates for receiving EPAS for further development, testing, and analytical support.

None of the candidate mainframes supported the extended version of Pascal that was on the WICAT system. EPAS was translated, therefore, into Programming Language/1 (PL/1), a language which: has character and numeric processing features similar to Pascal, supports file structures, and is used by other Army personnel planning systems.

EPAS has been translated to PL/1 on the National Institute of Health (NIH) computer system. Taking advantage of the mainframe's capabilities, support for yearly and weekly iterations has been investigated, features not possible on the DLF. GRC analysts believe it will be necessary to subsequently transport EPAS to the Army's FORECAST system for additional testing and evaluation. This will result in the ability to:

(1) Access real-time, operational data.

(2) Simulate a field test in an operational environment with the hardware and software used to support the day-to-day operation of the Army's personnel planning systems.

(3) Substantially reduce computer costs.

Investigate and Select Development Methodology

In order to develop and evaluate EPAS constructs in a controlled manner, alternative methodologies to develop the EPAS system and each of its components were investigated. Based upon our methodologies analysis, the EPAS framework and processing components were defined.

Since this is a research and development project, it was expected that many changes would be made to EPAS in order to evaluate candidate methodologies. This would have been difficult using traditional software development methodology which is strictly phased and includes data flow diagrams or flowcharts to represent the design. A systems development methodology was required, therefore, that supported developing analytical models rather than just making data base manipulations using panels (as with rapid prototyping). The initial approach was to construct programs from "building block" modules and then link them together. This approach could increase flexibility in evaluating new methodologies. Modules considered for the EPAS system framework were:

(1) Process Test System (PTS) to be the system controller and the overall user interface, running the EPAS components and generating evaluation reports.

(2) Process Construction System (PCS) to support defining building block components used to construct EPAS modules. (We had expected building blocks to be extensively used for applicant classification).

(3) Process Link System (PLS) to link the building blocks into a coherent system structure.

As research continued on the methodologies and design of the system, it was determined that the PCS and PLS components would not be cost-effective because:

(1) A building block approach did not efficiently support evaluating the methodologies under consideration for EPAS.

(2) The building blocks were so computationally complex that options and data base accesses could not be coded easily through the PCS.

(3) Switching in and out building block modules could be easily emulated using programming language INCLUDE statements and common module interfaces.

Thus, the Process Test System became the system framework and primary user interface into which candidate EPAS processing modules could be inserted and evaluated.

Provide a User and Developer Interface

Sections III and IV of this report described the basic functional capabilities required for EPAS. Figures III-2 and IV-2 presented a highly simplified view of EPAS' modules and their interrelationships. Supporting these basic functional areas required the development of a complex series of ancillary procedures and subsystems. Figure A-10 presents an expanded representation of EPAS as a full system, indicating some of the complexity involved in the EPAS system. Key elements of EPAS include:

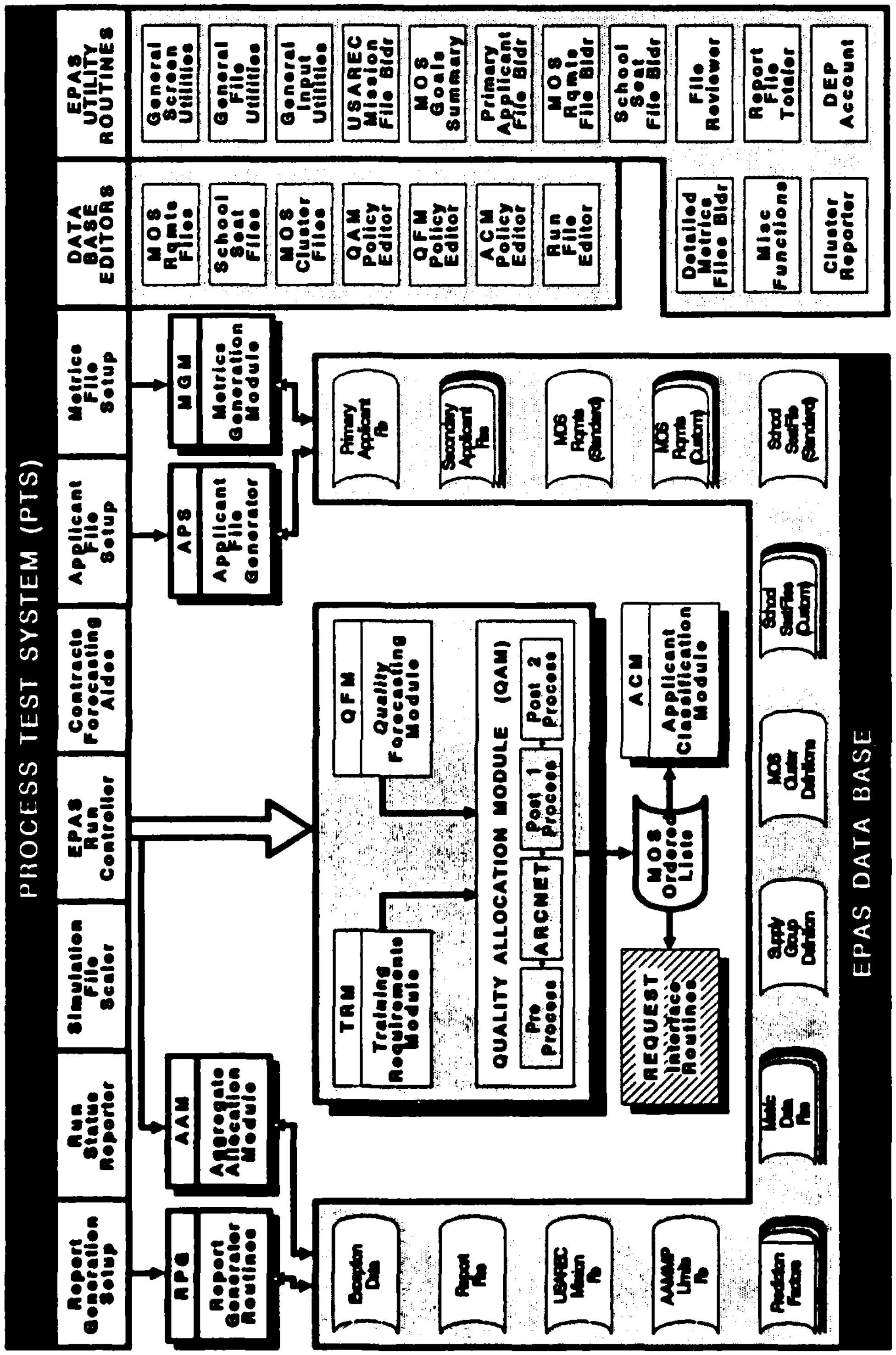


Figure A-10. The EPAS System

(1) The center of the figure depicts the various models and principle procedures described in this report, i.e., the TRM, QFM, QAM, ACM, etc., and shows their basic relationships. These routines define the actual simulation and classification procedures; the rest of the items depicted in Figure A-10 support this central system.

(2) The Process Test System (PTS) controls all system access. The procedures provided by the PTS can be divided into three basic categories:

(a) Setup Routines. These are routines which enable the user to interactively develop job streams for execution. These routines automatically provide the linkages between the user front end and the computer batch execution facilities.

(b) Editor Routines. These are routines which allow the user to access all data contained within the system.

(c) Utility Routines. EPAS was designed to utilize common routines. This allows the system to present a uniform appearance to users; in addition, it facilitates development and debugging by providing.

(3) The Data Base contains all data required by EPAS. Types of data within the data base include:

(a) Standard data -- unedited data from external sources.

(b) Customized data -- data modified by analysts to test policy alternatives.

(c) Parameter data -- control data from previous executions of EPAS providing convenient restart and rerun capabilities.

(d) Report data -- results of previous executions, both model output and exception reports

Because of EPAS' complexity, some means had to be included to simplify systems access and operation. Accordingly, an interactive, user-friendly "front-end" interface was developed which provides developers and users with a system interface and expedites debugging and fine tuning.[3] To meet these requirements, EPAS had to offer the following user access capabilities:

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3 The alternative to an interactive front end was to require users and developers to edit input data files using only the computer's standard editor, without error checks, and then combine these files into a job stream for execution.

(1) Menu driven controls with choices indicated via cursor controls, space bar or the depressing of the first letter(s) of the menu item desired. The indicated item is selected with the RETURN key.

(2) Consistent header labeling and panel identification indicating what operation is being performed.

(3) Error messages at the bottom of the screen when the erroneous data or parameters are entered (not after all items in the panel are entered).

(4) Full-screen presentations including reverse video and blinking.

(5) Error correction capability before proceeding to next panel.

(6) A capability to return to a previous panel.

(7) A capability to abort an operation without any adverse effects.

(8) User-named analysis data support.

(9) On-line tutorials and explanations.

(10) A standard editor to add, modify, copy or delete categories of EPAS parameters such as policies, MOS requirements, and the training program.

A tree-structured, interactive menu capability was developed to implement these capabilities. The tree-structure enables EPAS to automatically determine the next processing step based on the user's input. Each of the menues is designed to a common standard to facilitate the user's input. Figures A-11 and A-12 present examples of typical menues as implemented in the EPAS user interface. The principle items found on the menues are:

System: This identifies the EPAS system being executed. At present, only the Non-Prior Service (NPS) system has been implemented.

Menu Description: This provides a brief, clear-text explanation of the purpose of the menu.

Version Number: This is an informational item indicating the current EPAS version and release being executed.

Subsystem: This indicates the primary subsystem being executed.

Menu Number: This is a unique identifier for the menu. Each menu is identified in this manner to facilitate debugging and error checking.

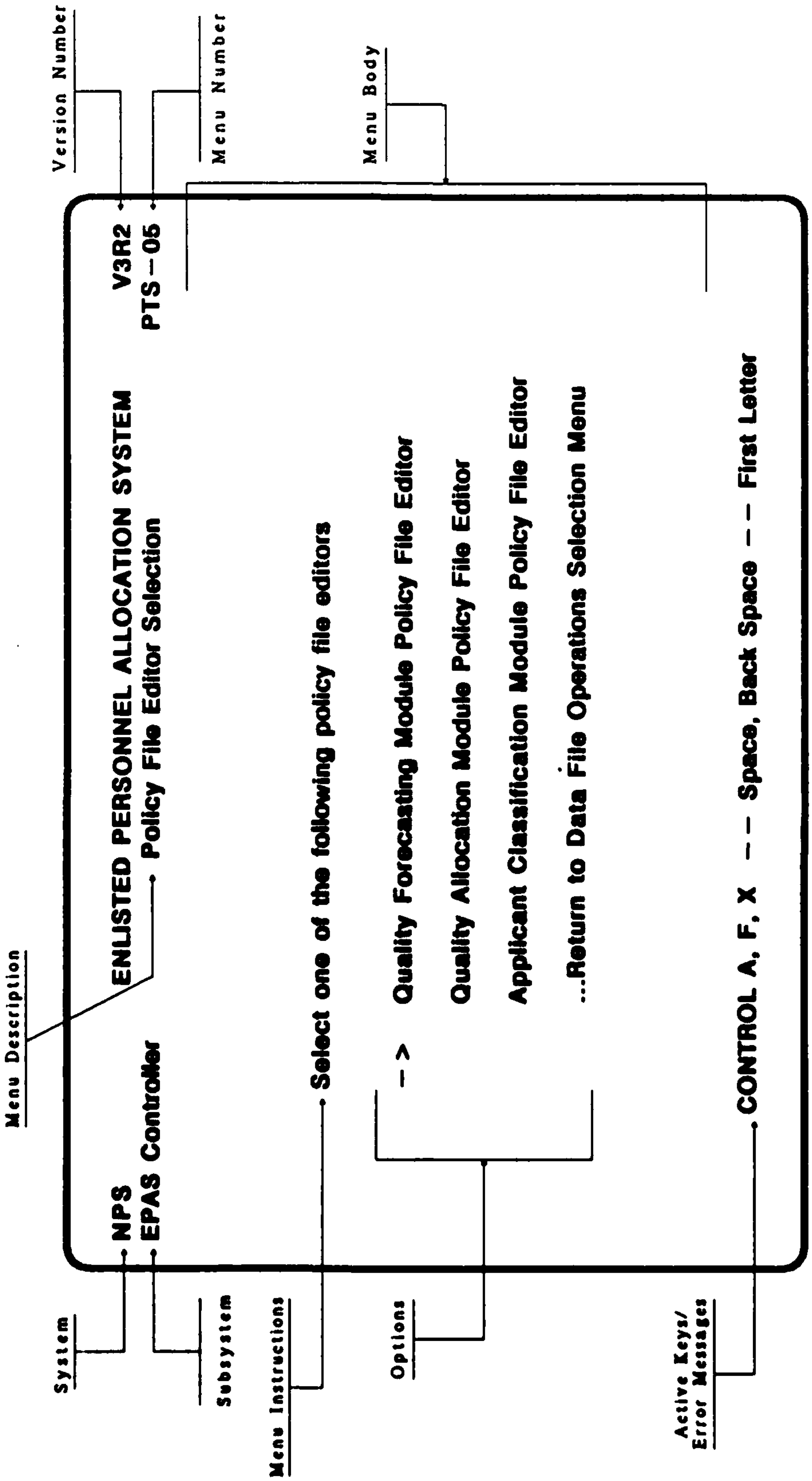

Figure A-11. EPAS Selection Menu

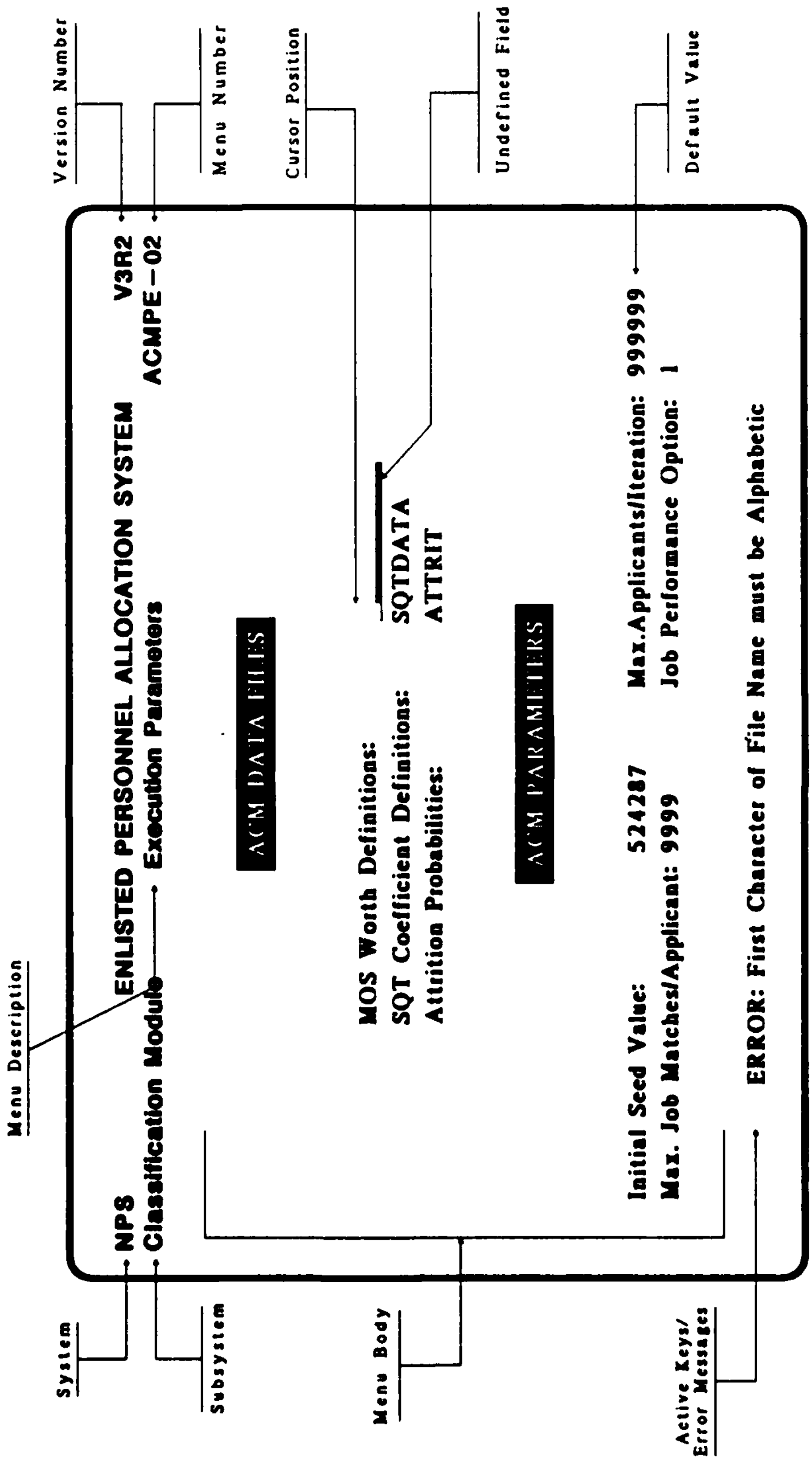

Figure A-12. EPAS Data Entry Menu

Menu Instructions: This is a terse, one-line message providing instructions about what action the user is to perform for the menu.

Menu Body: This section of the menu provides the information unique to the mene. It will vary depending on the specific type of menu being processed.

Figure A-11 depicts a typical selection menu in which the user is provided with a list of options and is instructed to select one or more from the list. A blinking arrow points to the the item currently being processed; selected items are highlighted with reverse video.

Figure A-12 depicts a typical data panel in which the user is to enter data. The cursor will automatically move to the next entry field when the ENTER key is pressed. If EPAS has been previously given a data value (the "default" value) it will be displayed in the appropriate field. If no default value has been given, a blank line will be displayed indicating entry is necessary.

Active Keys/Error Messages: The bottom lines of the screen are reserved for error messages. Normally blank, these lines will be filled in with an error message and/or special instructions whenever erroneous data is entered.

Standardized Editors

All data within EPAS is accessable to the user through a series of interactive editors. Access to the full spectrum of data provides the ability to easily alter any information within the model for policy analysis and the ability to query the current or simulated values for any part of the system. All editors have been standardized to provide the following capabilities:

(1) List. A listing of all current configurations for the data being addressed is provided. This feature is particularly usefull when generating multiple control files for alternative policy scenarios. It allows the user to quickly review which alternatives are available.

(2) Edit. Any of the current configurations may be accessed and altered.

(3) Copy. Any of the current configurations may be copied and assigned a new name. This provides the user with the ability to quickly formulate a new policy alternative based on the characteristics of some predefined configuration.

(4) Delete. Any of the current configurations, with the exception of the system default, may be deleted from the list of available options.

(5) Review. Any of the current configurations may be reviewed to identify current settings. Updating of the configuration is not authorized in the review mode.

Provide Execution Control

Analyses have clearly shown that EPAS has the capability of being a usefull tool for the Army, capable of providing significant improvements in individual allocation. If EPAS is to be of practical benefit, however, it must be useable as well as usefull. The EPAS concept will not be practical if system operation is so cumbersome or complex that Army analysts and managers are unable to use it.

Avoiding this potential problem implies a functional requirement to develop a user-friendly control environment. The following requirements directed design of the system execution controls:

(1) Support for any user-specified combinations of applicant, policy, MOS requirements, school seat and training, etc. input data files.

(2) Support for any number of iterations, starting at any time point; further, the system should support rerunning iterations.

(3) Support for automatic, on-line submittal of batch (off-line) EPAS runs. These submittals should include simulations and optimizations, report generation, metrics reference generation and applicant/contractee file generation.

(4) Support for control programs to control and monitor batch EPAS run submittals.

On-Line Operations Control. To meet the first three requirements, a file interface, called the Run File, was developed. This is the interface for users to specifify all execution-related files and parameters for batch operation. It also is the medium which the batch system uses to report on run status, temporary files to be used and other run-related information. An editor provides the user interface; it supports the following functions:

(1) Creating new run file information based on a standard run template.

(2) Modifying a previously-executed analysis; this includes the deleting of extraneous work files and other clean-up operations to support the new analysis.

(3) Deleting run file information.

(4) Listing all run file names with user selection capability for editing, creating or deleting.

(5) Reviewing run file information (read only operation - no modifications are allowed).

(6) Detailed error analysis to prevent an infeasible run request, such as requesting a third iteration when the first two iterations have not been run.

Information contained in the Run File record description is divided into five categories:

(1) Execution Related Parameters. These include the run name and description, the type of run, the run start date of the analysis, the number of iterations, the starting iteration (would be greater than 1 if restarting from a previous analysis), and the system abort indicator flag.

(2) File and Record Name Parameters. These include the names of the files (such as applicants and contractees, MOS clusters, DEP loss, metrics, MOS requirements, school seats and training plans) containing the data for the analysis.

(3) Output Related Parameters. These specify the reports generated after each iteration and the level of trace and debugging for each batch component.

(4) Processing Options. These include the ASVAB composite used (default is new composites, 1980 norm), scaling factors for the MOS requirements and training program. An applicant and contractee forecast match flag (if on, a contractee simulation population will be generated for each iteration that matches the projected population), and the optimization metric used with weights which permit linear combinations of up to three metrics. Scaling changes the relationship between the contractee supply and MOS requirements; we scale demand requirements up or down while holding supply constant.

(5) Historical Data Parameters. These are read only parameters which cannot be changed by the user. They include processing iteration information, run termination code, aborting module (if abnormal termination), last and current processing dates, and temporary file names for MOS requirements and school seat/training program information. These files have to be altered during EPAS processing so copies are maintained for each iteration in order to retain the original information.

Batch Operations Control. Batch job submittal procedures are different for each computer system due to operating system restrictions.

In the WICAT system, the Pascal code allowed direct access to operating system utilities. The system was coded to "fork" another job directly from the on-line program.

For the IBM system at NIH operating under the MVS/XA operating system, the submittal of batch jobs occurs after the on-line system has completed running. A Command List (CLIST) was developed to execute the on-line system and, at on-line system termination, check a return code to determine if any batch runs are scheduled. If so, the CLIST reads an interface file specifying the type of batch job (simulation, optimization, reports, metric generation, contractee file generation) and the Run File name. Based on this information, the CLIST edits a standard batch submittal JCL file by inserting the run file name and job card information. The edited file is then submitted for batch execution.

A batch control program has been developed for each of the batch operations. This program will read the Run File name from the parameter (PARM) statement in the execution JCL. All other information regarding the execution of the system is contained in the Run File.

Provide Execution Status Monitoring

An execution-status review module gives the user feedback on his EPAS run's execution. It provides up-to-date reporting of iteration information and displays all the exception reports generated for the run by each component. The exception reports tell the user about nonstandard conditions (such as a particular MOS not achieving its quality goal) and unrecoverable errors that could cause a run abort. They can be selected for a given module and/or iteration.

APPENDIX B
DETAILED FUNCTIONAL DESCRIPTION OF EPAS

The analyses which led to the current version of EPAS were documented in Appendix A. This appendix describes the detail of the EPAS implementation as of December 1987. This version of EPAS has been implemented on the National Institute of Health (NIH) IBM computer system, using a MVS/XA operating system with VSAM file access. All coding has been performed in PL/1, excepting the network solution algorithm, ARCNET. ARCNET is a proprietary software package developed by Analysis, Research Corporation, Inc. of Austin, Texas and coded in FORTRAN.

For the convenience of the reader, the procedures detailed in this appendix have been detailed in the same order as they were presented in the body of the report. Procedures covered are:

(1) Forecast Applicants/Contractees

(2) Determine/Project MOS Requirements

(3) Generate Aggregate Assignments

(4) Generate Detailed Assignments

(5) Report Results

(6) EPAS System Framework

FORECAST APPLICANTS/CONTRACTEES

This section presents the specific implementation of EPAS which is currently operational. It contains three main subsections:

(1) The forecasting model.

(2) The Supply Group methodology.

(3) The user interface.

The Forecasting Model

As discussed in Appendix A, EPAS provides the user with a choice of the specific forecasting model to be used. Recapping, the currently available techniques are:

(1) Dale-Gilroy (ARI) econometric model.

(2) Horne (ARI) econometric model.

(3) USAREC mission statements.

(4) GRC trend model.

(5) GRC econometric model.

The standard implementation uses the USAREC monthly mission model. Observations showed that the USAREC monthly mission statements provided a good forecast of the contractee supply, not surprising given that recruiters are rated based on how well they fulfill their mission. Tis technique was selected as the default methodologyas it appeared to provide the best overall forecast of annual supply because of its "self fulfilling" nature.

The EPAS forecasting routines first distribute the annual mission into Supply Groups and Recruit Station Months based on historical trends. The actual contracts are then monitored by the system and compared to the initial forecast. The forecasts are updated as variations from the anticipated arrivals occur, insuring that the annual mission statement remains constant.

Supply Group Methodology

The subject population is deterministically divided into subpopulations based on fixed demographics. This initial division is necessary to enable the models to deal with demographically-based congretional and Army policies and guidance such as the exclusion of females from skills with combat requirements.

The subpopulations are then further subdivided into differentiable clusters based on the nine ASVAB Aptitude Area Composite Scores. The standard technique for generating Supply Groups combines the nearest centroid sorting and Ward's minimum variance techniques. This approach deals well with the high intercorrelations found among the composite scores and results in clearly differentiable clusters within the demographic subpopulations.

A more detailed description of the anlaysis involved in generating the Supply Groups, along with the current formulations based on the FY86 population, may be found in Appendix A.

Provide User Interface

An important part of the EPAS design was to provide the means whereby Army managers and analysts can test alternative methodologies, e.g. forecasting models and Supply Groups. To satisfy this requirement, a file interface called the Quality Forecasting Module (QFM) policy file was developed. The contents of this file are shown in Table B-1.

This file contains the files and parameters required by the forecasting models. (Supply Group specifications and parameters are defined in another file interface, the Run file, defined later in this appendix). An editor provides the user interface; the editor's functions include:

(1) Creation of a new QFM policy file from a current QFM policy file or from a standard policy file template.

(2) Modification of the parameters of a policy file.

(3) Review of the current parameter settings for a policy file.

(4) Deletion of a policy file.

(5) Listing of all policy files.

The information contained within the QFM Policy File can be classified into four categories:

Execution-related Parameters. These include the policy analysis mode, i.e. whether forecasts should be generated or updated, and the specification of whether the generation of an input file for the quality allocation module (QAM) is needed. This file isn't necessary when the forecasting model is being tested.

File and Record Name Parameters. This includes the specification of the files containing the USAREC mission goals.

Forecasting Parameters. These include the specification of the forecasting model, number of years to forecast, whether seniors should be forecasted, the time increment to forecast (quarterly or monthly), and the specification of values for the independent variables e.g. the

TABLE B-1

QFM POLICY FILE RECORD STRUCTURE

NAME	TYPE	SIZE	DESCRIPTION
FNAME	CHAR	7	Unique name assigned to a QFM policy file
MISGOAL(10)	CHAR	11	USAREC mission statements, one per forecast year
SPLITFLAG	INT	2	Flag indicating if high school seniors should be forecasted
MOPT	INT	2	Flag denoting whether forecasts should be done monthly or quarterly
MODEL	INT	2	Coded value indicating which forecasting model to use
FFLAG	INT	2	Flag indicating whether the QAM input file should be created
MPARM(6,8)	FLOAT	4	Parameter values for each forecasting model for each forecasting year
MAXYRS	INT	2	Number of years to forecast
MAINOPT	INT	2	Policy analysis mode flag, i.e. to generate or update forecasts
SPLIT(7)	FLOAT	4	Male and female, AFQT Categories I-IIIA quartile split factors
EDSPLIT(12)	FLOAT	4	Monthly high school graduate / high school senior split factors

military and civilian pay differential. This enables the user to test different forecasting environments.

Supply-related Parameters. These include the percentages for splitting the AFQT Category I-IIIA into its two quartiles, I-II and IIIA, and for splitting the high school graduate category into graduates and seniors by calendar month. This provides the user control over the supply characteristics. For now, these parameters have to be specified by the user, but changes are planned which will allow the user to direct the system to automaticly use historical values. There are QFM policy file templates provided which already have this information entered.

DETERMINE/PROJECT TRAINING AND MOS REQUIREMENTS

This section presents the specific implementation EPAS' MOS requirements capabilities which is currently operational. It contains three main subsections:

(1) MOS Clustering Considerations

(2) The Training Requirements Module.

(3) Quality Allocation Module Cluster File

MOS Clustering Considerations

The primary goal in the generation of MOS Clusters was the preservation of characteristics necessary to support the assignment process. An additional goal was that the MOS within a clusters should be functional alike. To support these goals, MOS were deterministically clustered based on:

(1) Gender -- male, female

(2) Education Requirements -- high school only, other

(3) Quality Goals -- AFQT I-IIIA only, AFQT I-IIIB only, other

(4) DoD Occupational Categories

(5) Minimum ASVAB Aptitude Area Composite Score

A discussion of the analysis leading to these clustering factors, the specific methodology employed, and a listing of the MOS Clusters formed based on the FY86 MOS may be found in Appendix A.

The Training Requirements Module

The Training Requirements Module (TRM) performs all actions necessary to generate summary class seat information for the optimization routines. (The detailed allocation routines access the class file directly). The TRM has two primary activities:

(1) Exception checking

(2) Generating current class fill information

Exception Checking. After each iteration, the model status is checked to see if any exceptions have occurred. If an exception has occurred, an attempt is made to take corrective action and continue the simulation execution. If it is unable to continue, control is returned to the controlling module with the pertinent information.

TABLE B-2
EXCEPTION MESSAGES FROM THE TRAINING REQUIREMENTS MODULE

(1) AFQT Category IV bounds exceeded for MOS: XXX.

(2) Annual requirement cannot be met for MOS: XXX.

(3) Annual requirement for MOS: XXX has been overfilled.

(4) Annual requirement for MOS: XXX has been overfilled in FY2.

(5) Cannot meet annual high quality requirement for MOS: XXX.

(6) Error finding MOS: XXX for fiscal year YYYY in MOS Requirements File.

(7) Error finding MOS: XXX for fiscal year YYYY in School Seat File.

(8) The Actuals have exceeded the Optimal Goals in month MM.

where: MM ::= Month number
XXX ::= MOS name
YYYY ::= Year

In order to provide information to the analyst about the status of the MOS Training Seat fill, information on missing data, the under/over filling of class seats for individual MOS, etc. is output to an Exception Report. Examples of the exception reports messages generated by the Training Requirements Module can be seen in Table B-2. Information for use by the system programmer is also generated but is not intended for use by the Army's analysts.

Generating Current Class Fill Information. The Training Requirements Module (TRM) generates the MOS training information at the cluster level of detail as required by the QAM. The basic data necessary to perform the TRM functions is contained in two files: the School Seat and MOS Information Files.

School Seat File. The record structure for the School Seat File is shown in Table B-3. This file contains data for classes, summed by month, for every MOS. The monthly totals are sufficient for the needs

TABLE B-3
SCHOOL SEAT FILE DATA RECORD

NAME	TYPE	SIZE	DESCRIPTION
FNAME	CHAR	7	Name by which the School Seat file is to be identified
FISCAL_YR	CHAR	4	The Fiscal Year for which the data is applicable
ITERNMBR	CHAR	2	The iteration for which the data is applicable. Iteration "00" is the information before any simulation has occurred.
MOS_CLASS	CHAR	3	Military Occupational Specialty
CLASS_CODE	CHAR	1	Unique class identifier
METRICS	INT	4	An array containing summary information on metric values
MINORITY_CONT	INT	4	The total number of contracts signed by minorities
CAPACITY_MAX	INT	2	The maximum classroom capacity for AA for each month
CAPACITY_MIN	INT	2	The minimum classroom capacity for AA for each month
CAPACITY_NOM	INT	2	The optimal classroom capacity for AA for each month
CLASS_FILL	INT	2	The current classroom fill by month and demographic
COHORT_FILL	INT	2	The current cohort fill by month and demographic
COHORT_RQMT	INT	2	The portion of the classroom capacity reserved for cohort
RESERVE_NG	INT	2	The number of seats reserved for AR and NG personnel
TNG_WK	INT	2	The weeks portion of the course length
TNG_DAYS	INT	2	The days portion of the course length
AVAIL	CHAR	1	Flags indicating if course is available for males/females
COURSE_TYPE	CHAR	1	Type of training (AIT, OSUT)
LOCATION	CHAR	23	Location at which training is to occur
START_DATE	CHAR	6	The class starting dates

of EPAS as it is, foremost, a planning system. Real-time classification, for which individual class detail is required, is performed in the REQUEST system. When the REQUEST Information Module has been implemented, REQUEST will continue to perform this function using the guidance provided by EPAS.

The data contained within the School Seat File is dynamic, that is it will be updated by the model during execution. This updating allows the system to track its current fill, dynamically alter its payoff values, and insure that annual requirements are met in accordance with policies being evaluated.

Most of the data element descriptions for the School Seat File are self-explanatory. The information can be broken into six categories:

(1) File Directory Information. This is needed to keep track of valid File Names and number of files contained in the School Seat File.

(2) File/Record Information. This data is used to access the individual MOS at a given point in the simulation. It includes the File Name, Fiscal Year, Iteration Number and MOS Class Code.

(3) Date Information. This data is used to determine when a class is to take place so that recruits can be placed in the DEP for the correct amount of time.

(4) Class Capacity Information. These fields contain information on the minimum, optimal and maximum number of recruits that may be placed in an MOS during a given class.

(5) Current Class Fill Information. These fields contain information on the number of seats all ready filled by month. This is used in determining the number of recruits that may be placed in a given class.

(6) Metric Information. These fields contain information on the average metric scores for the seats already filled, by month.

MOS Information File. The data record structure for the MOS Information File is given in Table B-4. This file contains information necessary to describe the characteristics and requirements of each MOS. Unlike the School Seat File, the data within this file is static, i.e., it is not updated during the execution of the model.

Most of the data element descriptions for the School Seat File are self-explanatory. The information can be broken into five categories:

(1) Unique Identification. As different policy alternatives are defined and tested by the EPAS user, some means must be available to distinguish the various options. For example,

TABLE B-4

MOS INFORMATION FILE DATA RECORD

NAME	TYPE	SIZE	DESCRIPTION
FNAME	CHAR	7	Unique file name
CURRENT_FY	CHAR	4	Fiscal year for which data is applicable
MOS_NAME	CHAR	3	MOS for which data is applicable
AA_RQMT	INT	4	Annual MOS accession requirement
BONUS_NBR	INT	4	Number of cash bonuses available
QUAL_GOAL_F(6)	INT	4	Female goals divided by AFQT Category and education
QUAL_GOAL_M(6)	INT	4	Male goals divided by AFQT Category and education
APT_LEVEL(3)	INT	2	Minimum cut scores
FEMALE_PERCENT	INT	2	Percentage of annual requirement to be filled by females
JOB_DIFF_SCORE	INT	2	Measure of job difficulty corresponding to new aptitude measures -- for future use
MINORITY	INT	2	Percentage of annual requirement to be filled by minority accessions
PERCENT_AVAIL	INT	2	Probability of the MOS being available -- for future use
PRIORITY	INT	2	MOS priority relative to other entry MOS
RST_FIELDS(10)	INT	2	Fields in applicant's record for which MOS restrictions apply
RST_OPS(10)	INT	2	Type of operator applicable to restricted fields
CAS	BIT	1	Flag indicating civilian acquired skills are applicable
COMBAT_ARMS	BIT	1	Flag indicating skill closed to females
ENLIST_BONUS	BIT	1	Flag indicating enlistment bonuses are available
HI_TECH	BIT	1	Flag indicating MOS is classified as highly technical
LANG_RQMT	BIT	1	Flag indicating MOS has a special language requirement
MODERN	BIT	1	Flag indicating MOS has been classified as a force modernization skill
SEC_INT	BIT	1	Flag indicating MOS requires special security interview

TABLE B-4 (Continued)
MOS INFORMATION FILE DATA RECORD

NAME	TYPE	SIZE	DESCRIPTION
XTRA_FLAGS	BIT	9	Reserved for future flag fields
APT_AREA	CHAR	2	MOS Aptitude Area
APT_RQMTS(3)	CHAR	2	Aptitude areas for which minimum cut scores are applicable
CMF	CHAR	2	Career Management Field to which MOS belongs
MOS_TITLE	CHAR	24	Clear-text name of MOS
OPTION_FLAG(10)	CHAR	2	Options available to MOS
PREREQ(3)	CHAR	3	Prerequisite MOS for this MOS
REMARKS	CHAR	79	Field for general remarks
RST_VALUES(10)	CHAR	7	Restricted data values corresponding to fields in applicant record
TERM_ENLIST	CHAR	3	Initial term of enlistment, in years

simulations may be desired to determine the impact of raising the minimum cut scores in highly technical skills; this would require having at least two MOS Information Files, one containing the standard cut scores, the other containing the proposed increased scores. Identifier fields within the data record provide the ability to select the appropriate file.

(2) Skill Restrictions. The second type of data elements within the record define the various restrictions which apply to the MOS. Before an applicant can be considered for an MOS, checks are made to ensure that the applicant meets all of the entry restrictions associated with the MOS. Failure to meet any of the restrictions will result in that applicant being rejected from consideration. Entry restrictions currently processed are:

(a) Aptitude Cut Scores. Every initial entry MOS has a minimum ASVAB composite score associated with at least one, and as many as three, ASVAB Composite Aptitude Areas. Applicants must meet the minimum score for all applicable aptitude areas.

(b) Combat Arms Restrictions. The second type of entry restriction prohibits female recruits from serving in MOS which have been identified as having a combat requirement.

(c) Skill Specific Restrictions. The third type of entry restrictions which are supported are those unique to the MOS skill requirements. For example, electronic maintenance/repair MOS require the ability to clearly distinguish colors; other MOS may require a valid driver's license, or a certain typing speed, or a minimum score on a specialized aptitude test.

(3) Policy Guidelines. The next type of data provides policy guidelines, e.g., annual training requirement and quality goals. These data provide the information used to manage the distribution of applicants.

(4) Enlistment Options. These data support the Army's bonus/ option programs.

(5) Descriptive Information. The final category of data describes attributes of the MOS within the system. This data provides the potential for managers to selectively identify MOS for special handling or processing considerations.

TRM Processing. Before each iteration of the model, the TRM uses the information contained in the School Seat and MOS Information files to generate class requirements for the optimization model.

First, the remaining (i.e., unfilled) seats for each MOS class are identified. This value is taken as the difference between the current contracts for the class and the maximum class size. (The maximum class size is used to insure that the optimization routines have the flexibility necesary to meet requirements).

Next, this value is scaled so that the sum of the remaining seats does not exceed the remaining annual fill requirement.

The resulting value is used by the QAM to define the optimal flow values for its arcs. If each of these is met precisely, the resulting MOS fill will precisely match the annual requirement, meet quality targets, and be garaunteed to be no greater than the maximum class size. The realities of the simulation, of course, are such that precise matching will generally not occur.

The TRM, therefore, also generates a maximum flow value for each class, providing the optimization model with the ability to shortfall a class in one month while overfilling the optimal value in another. The maximum flow value is computed as a predefined percentage over the largest of the optimal flow values. Each class for a given MOS is assigned the same maximum flow value.

Checks are then made for classes which have a minimum size. The number of seats which must be filled to bring the class to this value is computed directly as the difference between the current fill and the minimum fill.

Next, the minimum, optimal, and maximum values are compared to insure that they lie in the proper logical order, that is:

minimum optimal maximum

Adjustments are made when necessary to insure that this relationship occurs for each MOS/RSM. If adjustments are made, the appropriate error message is sent to the Exception Report enabling the analyst to track any corrective action performed by the TRM.

This process is performed for both the total MOS requirement and the quality goals. The final step performed by the TRM is to sum the MOS into the appropriate MOS Clusters.

A detailed explanation of how the optimization routines utilize these flow values is found in this appendix's next major section, GENERATE AGGREGATE ASSIGNMENTS.

Quality Allocation Module Cluster File

To communicate the information generated by the TRM to the optimization model, the Quality Allocation Module (QAM), an interface file known as the Requirements Module Cluster File (Cluster File) was developed. The information contained in this file is shown in Table B-5. In addition to the generated class bounds, the TRM communicates information such as the Aptitude Area with which an MOS Cluster is associated, the ASVAB cut score (i.e., the minimum ASVAB Aptitude Area Composite Score necessary to qualify for MOS within a cluster), and the total and remaining annual demand.

Most of the information contained in the Cluster File is self-explanatory. The information is divided into four categories:

(1) Execution related parameters. These include the name of the run, the current iteration number and the cluster number. This information is used by the QAM as a key to access information for a specific run, iteration and cluster in the Cluster File.

(2) Eligibility Requirements. The Army Standard Vocational Aptitude Battery (ASVAB) score for a specific Aptitude Area is used by the QAM to determine recruit eligibility for the given cluster. A value is also used to indicate if females may be accepted.

(3) Annual Demands. The total annual demand is given in number of school seats available for the current fiscal year. The total number of school seats yet to be filled in the current fiscal year is also given.

TABLE B-5
TRAINING REQUIREMENTS MODULE OUTPUT FILE RECORD STRUCTURE

Record Name: RMCLUST_REC

NAME	TYPE	SIZE	DESCRIPTION
FNAME	CHAR	7	Name of data file
ITERNUMBER	CHAR	2	Iteration number
CLUST_NUM	CHAR	2	Cluster number
ASVAB_CUT	INT	2	ASVAB cut score
SUM_LOW_BOUNDS	INT	4	Minimum bounds on number of school seats to be filled for cluster
SUM_NOM_BOUNDS	INT	4	Nominal bounds on number of school seats to be filled for cluster
SUM_MAX_BOUNDS	INT	4	Maximum bounds on number of school seats to be filled for cluster
SUM_CATIV_BOUNDS	INT	4	Category IV bounds on number of school seats to be filled for cluster
SUM_HS_BOUNDS	INT	4	High School Graduatetargets on number ofschool seats to befilled for cluster
SUM_ANNUAL_DMD	INT	4	Total number of schoolseats to be filled forthis cluster
REAL_ANNUAL_DMD	INT	4	Total number of schoolseats left to be filledfor this cluster
CLUST_ID	CHAR	3	Cluster ID
APT_AREA	CHAR	2	Aptitude area
COMBAT_ARMS	CHAR	1	Used to exclude female personnel from cluster

(4) <u>School Seat Bounds</u>. Information is given for the following areas:

a. The minimum number of school seats to be filled.

b. The optimal number of school seats to be filled.

c. The maximum number of school seats to be filled.

d. The number of AFQT Category IV recruits that may be placed in class seats.

e. The number of High School Graduates that need to be placed in class seats.

GENERATE AGGREGATE ASSIGNMENTS

The aggregate model provides the optimal policy guidance necessary to achieve the goal of improving the selection, classification, and utilization of Army enlisted personnel. It provides support for the both the simulated (Headquarters Planning Subsystem) and real-time (REQUEST) environments.

The current version of EPAS utilizes the network formulation, the Quality Allocation Model (QAM), to generate the requisite optimal guidance for both environments. Specific aspects of this implementation discussed in this section are:

(1) Determining assignment cost criteria. Details of the current version of the Metric Generation Module are presented.

(2) Network Model Formulation. Details of the network model are presented.

The linear program forumulation, the Aggregate Allocation Module, has not been implemented at this time. A discussion of the formulation being tested was presented in Appendix A.

Determine Assignment Cost Criteria

The Metric Generation Module (MGM) is a supporting routine which was developed to generate the cost criteria used to generate optimal allocations. (In the context of optimization models, cost refers to a utility measure (or "metric") by which different solutions may be compared).

MGM Processing. EPAS gives the user several options from which the optimization metric may be chosen. Currently implemented options are:

(1) Aptitude Area score.

(2) Predicted Skill Qualifications Test (SQT) score.

(3) Relative Utility of MOS Assignment.

(4) Predicted Attrition Behavior.

(5) Delayed Entry Program (DEP)/Attrition Costs.

The underlying methodology used by the MGM and a discussion of each of the available optimization metrics can be found in Appendix A.

MGM Input. The average metric values generated by the MGM will be sensitive to two factors:

(1) The definitions of the aggregations, i.e., how the Supply Groups and MOS Clusters are defined.

(2) The data to be used to generate the individual metrics.

The system user must, therefore, have the means to input which aggregations and data sources are to be used. This input is defined through a series of interactive menues in the System Driver routines. Actual MGM execution is performed as a batch submission from the driver routines. Required inputs to the MGM are:

(1) Filenames. The names of files which define the environment in which the MGM is to operate must be provided. The necessary files are:

   (a) Output Name. This is the name by which the generated metrics and all associated hard-copy reports will be identified.

   (b) Historical Accessions File. This file contains the input stream of historical accessions records on which the average metrics will be computed.

   (c) Attrition Data File. This is the file which contains the detailed first term attrition data.

   (d) Cluster Definition File. This file defines the MOS Clusters to be used.

   (e) Composite Definition File. This file defines the methodology and values to be used in computing the Aptitude Area Composite scores from the ASVAB subtest scores.

   (f) MOS Information File. This file defines the various restrictions applicable to an MOS, e.g., male only, quality goals, etc.

   (g) SQT Prediction File. This file contains the detailed ridge regression coefficients upon which the average SQT scores will be computed.

   (h) Utility Coefficients File. This file contains the tables providing the relative utility associated with predicted job performance.

(2) Printer Control. The second panel requests printer output control information. In addition to the detailed metric data files (which are automatically generated), the user may request additional, hard-copy output. The two options are:

(a) Printer-Ready Output. This is simply a hard copy of the data values contained in the metric files.

(b) Log Trace File. This is a file which traces key points within the MGM. If selected, it will contain trace messages and error messages monitoring the progress of the computations.

(3) Iteration Control. The next panel requests iteration control information. This data allows testing and checkpointing capabilities. Input parameters are:

(a) Maximum Applicants. This parameter limits the number of accessions records to be scored in each processing month. It provides the ability to decrease run time, at the expense of obtaining accurate data for the entire file.

(b) Beginning Date. This defines the recruit month corresponding to the first iteration, that is iteration number one.

(c) First Iteration Number. This parameter defines the first month to be processed; in effect, providing the checkpoint restart capability. That is, if the first month is any value other than one, the MGM will restart from the previous month.

(d) Last Iteration Number. This parameter defines the last month to be processed. It provides the ability to run partial year tests on new input files. The MGM final computations on the data and generation of the output will only occur when the last iteration number is twelve.

MGM Output. The record structures for the output generated by the MGM are shown in Table B-6; separate files are generated for each metric, each having the same record structures. The first record structure, METRICCHAR, applies only to the first record in the file. It defines the characteristics of the data records which follow; key elements of this data record are:

(1) FILENAME -- separate metric files should be generated as changes occur in the definitions of Supply Groups, MOS Clusters, and/or metric computations.

(2) MINMAX -- some of the metrics, for example, SQT score should be maximized; other metrics, such as attrition, should be minimized. This field tells the QAM's preprocessor what type of optimization should be performed.

TABLE B-6
RECORD STRUCTURES FOR MGM OUTPUT

NAME	TYPE	SIZE	DESCRIPTION
First Record: METRICCHAR			
FILENAME	CHAR	7	Name of data file
METRIC_TYPE	CHAR	1	Type of metric data
RECORD_NBR	CHAR	2	Always "00" in first record
SUPPLYGP	INT	2	Always zero in first record
NBRSUPPLYGPS	INT	2	Number of supply group records which follow
MINMAX	INT	2	Flag indicating if metric is to be minimized (0) or maximized
MINMETRIC	INT	4	Smallest metric value for eligible population
MAXMETRIC	INT	4	Largest metric value for eligible population
MININELIG	INT	4	Smallest metric value for ineligible population
MAXINELIG	INT	4	Largest metric value for ineligible population
SCALEFACTOR	INT	4	Scaling factor used to convert metric values to real
SOURCEFILE	CHAR	93	Name of the file from which the metrics were generated
FILLER	CHAR	483	Padding to end of record
Subsequent (Data) Records: METRICREC			
FILENAME	CHAR	7	Name of data file
METRIC_TYPE	CHAR	1	Type of metric data
RECORD_NBR	CHAR	2	The number of the supply group
SUPPLYGP	INT	2	The number of the supply group
NBRCLUSTERS	INT	2	Number of MOS Clusters
METRIC (75)	INT	4	Metric value for eligibles
INVMETRIC (75)	INT	4	Metric value for ineligibles

(3) MINMETRIC/MAXMETRIC -- metrics differ in the scale by which they are measured. Attrition, for example, varies from 0.0 to 1.0 while Aptitude Area varies from 40 to 160. The QAM scales the metric values to a consistent range using the minimum and maximum values to bound the necessary computations.

(4) SCALEFACTOR -- for computer speed, all numeric values are defined to be integers. In fact, they are real numbers with varying precision. This data element defines the adjustment necessary to compute the actual value. An attrition value of 0.185, for example, would be entered as I85 with a SCALEFACTOR = 1000.

(5) SOURCEFILE -- this is the name of the raw data file from which the metrics were computed. This variable provides documentation if needed for future reference.

All subsequent records use the structure as defined by METRICREC; one data record will exist for each supply group being used. Key variables within this record structure are:

(1) FILENAME -- separate metric files should be generated as changes occur in the definitions of Supply Groups, MOS Clusters, and/or metric computations.

(2) NBRCLUSTERS -- this variable defines the number of MOS Clusters which follow in the data record. It is used to determine how many elements of the metric arrays which follow contain viable data.

(3) METRIC -- the average metric value for the eligible populations. This is the value that will be used by the optimization model and the report generators as the cost value.

(4) INVMETRIC -- the average metric value for ineligible populations. This is the value that will be used by the optimization model and the report generator for combinations deemed invalid by current policy.

The MGM also generates hard copy output of the average metric values. Figure B-1 shows a typical page from this printed output. The title at the top of the report identifies the type of data being displayed (in this example, "Predicted SQT Performance") and the file name under which the data has been saved ("PSSDATA/R84NEWB.M2"). The column headers identify the MOS Cluster number for which the data is applicable; the rows identify the Supply Groups.

Each supply group has two lines of data: the first (e.g., "1/E") is the average scores for the eligible population; the second (" /I") is the average scores for the ineligible populations. A score of zero (0.00) indicates that no records were found for that Supply Group/Category/MOS Cluster. When this occurs, the data for the complementing category will be used. For example, Supply Group #11 has no eligibles for MOS Cluster #1. If policies are changed to allow Supply Group #11 personnel into MOS Cluster #1, the models will use the average score generated for the ineligible population (57.05 in this example).

Network Model Formulation

The network model optimizes the allocation of NPS recruits (clustered into Supply Groups) among MOS (clustered into MOS Clusters). The model has been designed to reach a feasible solution regardless of the circumstances, e.g., whether or not the recruit supply is sufficient to meet the MOS demand.

AGGREGATE METRIC VALUES

Predicted SQT Performance

PSSDATA/R84NEW8.M2

SUPPLY	CLUSTER NUMBER																
GROUP	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1/E	91.67	78.05	89.50	81.87	75.22	83.19	77.99	77.57	79.75	81.21	77.19	79.73	74.29	80.87	74.29	83.28	82.90
/I	65.99	72.59	82.82	72.35	76.80	81.93	76.64	77.97	66.03	75.00	71.04	72.97	61.70	71.73	72.94	80.47	70.70
2/E	85.81	84.27	98.37	89.48	88.94	95.70	88.46	88.55	85.49	93.47	89.83	90.87	96.84	91.21	96.84	96.56	90.72
/I	84.93	87.51	98.37	90.19	91.45	96.20	88.49	89.32	85.49	84.12	89.83	86.48	96.84	91.21	96.41	96.62	80.17
3/E	78.13	76.52	94.10	81.29	79.00	87.66	81.54	81.60	75.29	87.02	80.40	83.04	85.68	84.71	85.68	88.84	86.53
/I	73.45	78.82	94.10	78.98	82.43	88.47	81.47	82.56	70.39	79.05	74.07	78.71	85.68	69.29	84.89	88.70	74.10
4/E	79.22	72.38	92.42	79.05	71.76	85.25	78.18	78.25	67.22	85.79	73.51	78.69	84.83	82.57	84.83	85.59	80.59
/I	75.15	75.01	92.42	77.96	75.85	86.14	78.14	79.33	63.11	81.52	68.13	78.42	84.83	71.68	84.03	85.52	71.69
5/E	91.60	83.47	85.32	87.06	76.11	87.25	79.71	77.59	84.27	75.95	80.93	78.24	71.14	83.79	71.14	81.64	85.03
/I	64.15	69.00	81.57	69.69	69.98	76.58	71.52	72.79	61.45	71.91	63.72	69.16	57.29	69.49	65.20	73.99	69.31
6/E	88.12	70.25	88.02	72.55	66.39	79.71	74.29	74.19	65.42	79.89	69.39	74.06	72.64	78.50	72.64	79.58	79.51
/I	61.49	69.25	83.37	69.88	69.47	78.93	74.06	75.36	58.30	75.21	65.10	70.88	62.71	69.30	71.24	77.96	67.91
7/E	90.86	77.14	84.71	72.71	59.19	77.30	70.84	70.53	72.71	74.94	65.18	69.60	66.72	76.64	66.72	75.36	78.31
/I	55.07	65.12	85.96	64.32	60.54	73.74	70.28	71.47	48.72	72.31	57.70	64.92	59.01	66.93	63.65	72.48	64.37
8/E	77.17	69.12	89.67	72.81	64.47	80.89	74.60	74.65	60.61	81.62	67.88	73.33	79.00	79.42	79.00	80.99	79.84
/I	66.47	69.83	89.67	73.58	68.60	81.28	74.62	75.90	55.81	79.35	63.62	74.11	79.00	69.64	78.11	80.83	67.89
9/E	91.07	84.03	83.32	86.97	79.28	87.37	79.59	78.25	83.62	73.93	80.62	77.89	73.52	87.33	73.52	84.26	85.54
/I	59.94	66.26	80.10	66.24	61.93	72.90	68.37	69.39	55.64	68.33	60.23	64.89	55.18	66.97	59.85	70.61	67.30
10/E	0.00	0.00	80.45	0.00	0.00	0.00	0.00	78.25	0.00	72.05	79.97	79.66	76.68	88.02	76.68	82.23	81.73
/I	45.37	60.02	78.37	55.42	48.89	65.75	65.52	65.97	37.30	64.00	47.56	58.24	21.02	62.95	51.33	65.12	60.92
11/E	0.00	0.00	84.66	0.00	0.00	0.00	0.00	68.12	0.00	71.43	56.75	57.51	70.07	75.21	70.07	73.04	76.86
/I	57.05	62.35	85.66	65.06	53.96	72.88	68.10	69.05	41.13	74.48	52.00	64.68	67.00	65.93	68.72	72.31	61.76
12/E	0.00	0.00	80.03	0.00	0.00	0.00	0.00	64.43	0.00	67.53	60.47	57.81	59.87	73.27	59.87	68.95	74.48
/I	46.43	58.76	81.92	56.84	47.96	67.07	64.92	65.81	33.98	67.38	46.21	58.60	55.58	62.86	55.80	66.47	59.24
13/E	80.20	79.54	93.43	82.04	82.60	87.80	82.35	82.85	77.53	86.56	81.79	83.92	83.67	84.78	83.27	89.26	84.67
/I	71.86	72.80	93.43	75.45	74.12	78.98	79.52	79.41	70.66	78.26	74.49	77.00	73.54	72.46	73.02	80.61	73.70
14/E	91.97	83.55	90.87	89.16	83.26	88.19	81.96	81.30	85.49	80.68	83.45	84.49	79.86	85.77	79.71	87.65	88.46
/I	77.31	71.62	80.39	76.53	73.32	74.53	71.75	71.16	71.43	76.63	72.92	75.73	61.52	73.78	60.92	76.61	73.92
15/E	87.30	88.09	98.41	91.05	93.08	96.76	90.67	91.06	88.82	94.53	92.49	92.79	96.98	91.99	96.79	97.80	92.63
/I	82.00	74.61	98.41	82.96	93.08	96.76	90.67	91.06	78.55	83.85	92.49	93.17	96.98	91.99	96.79	97.80	74.98

Figure B-1. Sample MGM Output

A diagramatic representation of the network model is depicted in Figure B-2; the symbology used in this figure is explained in Table B-7.

A "Super Source" (SS) containing artificial "super" recruits who qualify for every MOS in every time period is used to insure an adequate supply of recruits regardless of the MOS demand. These artificial recruits are assigned a very high assignment cost, such that they will be used only as a last resort to insure feasibility. The supply "M" represents the number of artificial recruits which had to be entered into the model. In the event that artificial recruits were used, exception reports (defined below) will be generated identifying the location at which this substitution was required.

If the Super Source is not needed (that is, the forecasted supply satisfies the demand), these artificial recruits flow harmlessly to the Super Sink (SK). The Super Sink is described in more detail later.

The SG_{ij} (Supply Group) nodes collect forecasted supply (FS_{ij}) for each supply group i in month j.

The AH_{km} nodes represent quality (AFQT Categories I-IIIA) recruits assigned to MOS Cluster k in month m; the AL_{km} and $A4_{km}$ nodes correspondingly represent AFQT Category IIIB (AL) and AFQT Category IV (A4) recruits.

The AT_{km} nodes collect I-IIIA, IIIB and IV assignments to MOS Cluster k in month m. The MT_k nodes collect *all assignments* to MOS Cluster k in months one through twelve, with AR_k being the twelve-month demand for MOS k.

The actual formulation is somewhat more detailed, and is too involved to clearly depict on a single sheet of paper. A "snapshot" of a specific group of arcs and nodes will be shown in a later figure when expansion becomes necessary. Until that point, Figure B-2 can be used as a guide to the network.

Most of the constraints and goals used to define the model are calculated in the Training Requirements Module (TRM) of EPAS discussed in the previous section. These include twelve-month and fiscal MOS requirements, AFQT Category IV limits, and AFQT Categories I-IIIA missions. Sources of the remaining constraints on the model are identified in the discussions that follows.

MOS Requirements. Enforcement of both the twelve-month and fiscal-year MOS requirements is accomplished by using these requirements as lower bounds in the network formulation, as explained in the MOS Cluster Collector Nodes section below.

AFQT Category Requirements. The AFQT category requirements are also modeled as arc bounds. AFQT Categories I-IIIA requirements appear as lower bounds (see the AH_{km} to AT_{km} arc in Figure B-2) while AFQT

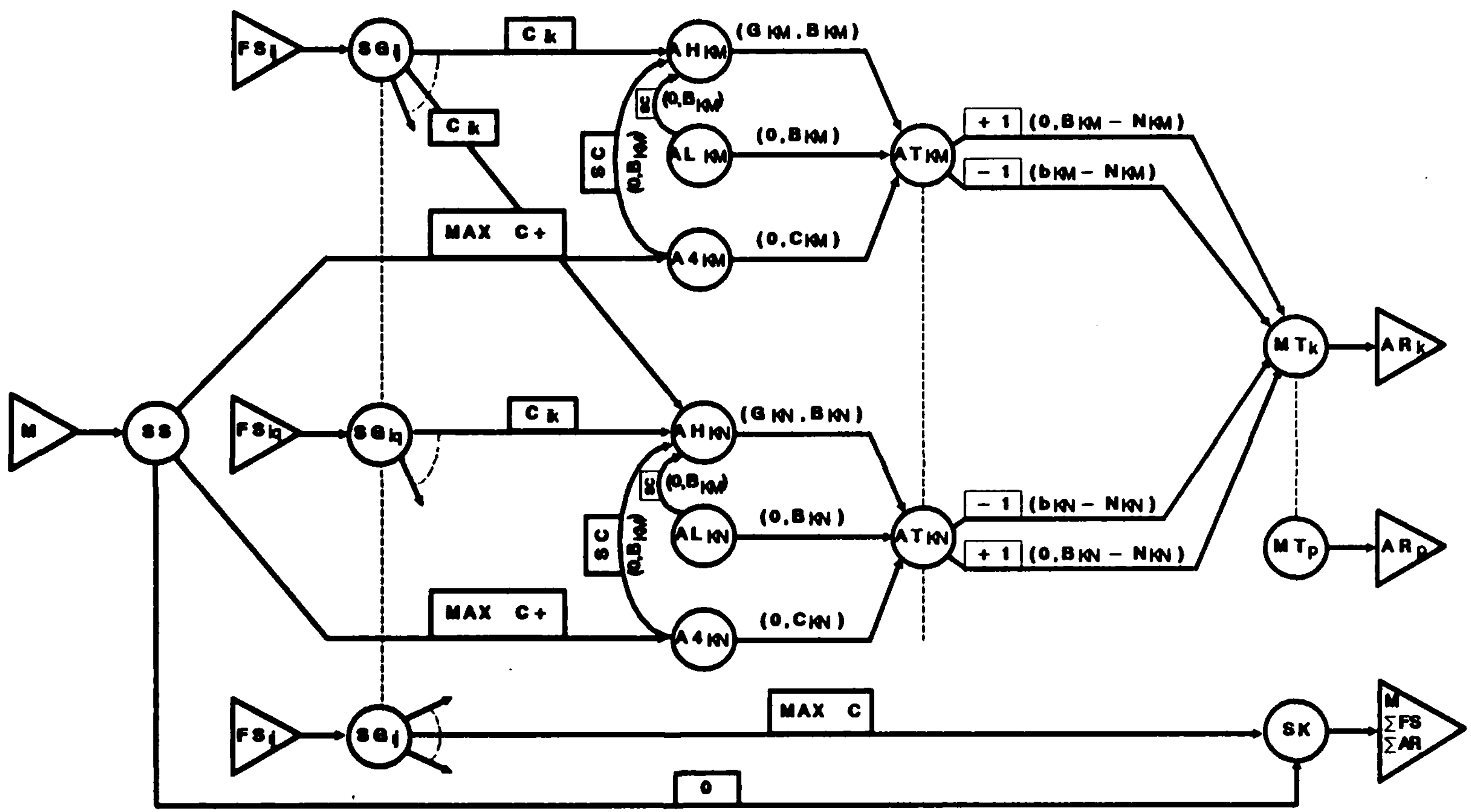

Figure B-2. EPAS Network Diagram

TABLE B-7
EPAS SIMPLIFIED NETWORK SYMBOLOGY

Definition of Terms

NODES:

SG_{ij}	-	Supply Group i recruits signing a contract in month j.
AH_{km}	-	Collector for quality (AFQT Category I-IIIA) enlistees who are assigned to training class for job k starting in month m.
AL_{km}	-	Collector for AFQT Category IIIB enlistees who are assigned to classes for job k starting in month m.
$A4_{km}$	-	Collector for AFQT Category IV enlistees who are assigned to training classes for job k starting in month m
AT_{km}	-	Collector for job k in month m.
MT_k	-	Annual collector for job k
SS	-	Super source, allowing for shortfalls in meeting minimum class size or annual requirements
SK	-	Super sink, representing the year-end DEP pool

PARAMETERS:

FS_{ij}	-	Forecasted supply for Supply Group i in month j.
AR_k	-	Annual job requirement for job k
b_{km}	-	Lower bound of class size for job k in month m.
B_{km}	-	Upper bound of class size for job k in month m.
G_{km}	-	Goal for quality recruits for job k in month m.
N_{km}	-	Optimal class size for job k in month m.
$C4_{km}$	-	Cap on category IVs for job k in month m.
SC	-	Cost of substituting an AFQT Category IIIB or IV when a quality goal cannot be met.
C_{ik}	-	Cost of assigning an enlistee from Supply Group i to job k based on the selected objective function.

Category IV limits appear as upper bounds (see the AL_{km} to AT_{km} arc in Figure B-2).

MOS Restrictions. Education and gender restrictions are used at the start of an EPAS run in determining eligibility for a Supply Group's assignment to an MOS Cluster. Since both Supply Groups and MOS Clusters may be redefined by the user, and MOS restrictions may be changed (e.g. an MOS which previously disallowed females may now permit them), it is necessary to determine eligibility at the start of each new EPAS run.

These restrictions (e.g. no females in combat MOS; no AFQT Category IV recruits permitted; etc.) are used to build an eligibility matrix by Supply Group by MOS Cluster. Then, if a Supply Group is flagged as being ineligible for assignment to a certain MOS Cluster, that Supply Group is simply not "connected" to it. That way, no assignment recommendations will be made if they violate the policy environment under which EPAS.

DEP Limitations. Implementation of DEP limits is accomplished through the QAM Policy File. The data elements associated with the QAM Policy File are shown in Table B-8. In the current design, the user enters minimum and maximum allowable DEP length in months for each demographic group (defined by gender, education, and AFQT category).

The QAM policy file itself is an indexed sequential data file with a unique, user-defined name as its key. As in other editors within EPAS, the user provides the name of the policy file to be edited or created. The user has the capability to copy an existing QAM policy file to a new, user-provided name, edit or delete an existing policy file, or list all defined QAM policy files. An additional policy parameter, the number of MOS-Cluster recommendations to be passed from the QAM to the detailed assignment process (discussed below) for each supply group, is also input using the QAM policy editor.

Gender Missions. Modeling proportional gender missions is not possible in the pure network design used in EPAS. Gender missions (that is, specific goals for specific MOS) are not stated by AFQT category, whereas all remaining MOS missions are by AFQT category. Therefore, to incorporate the gender goal, a non-network set of constraints would have to be used. Although this is mathematically possible, the resultant model's solution time would be greatly increased, while the amount of additional information gained, relative to the cost of solving such a model, is slight.

However, the network structure permits testing the feasibility of total gender missions and includes gender constraints. In addition, when classification simulation is performed, the detailed assignment process (ACM) meets these gender missions. Therefore, constraining the network model to incorporate gender missions is not required.

TABLE B-8
RECORD STRUCTURE FOR QAM POLICY FILE

NAME	TYPE	SIZE	DESCRIPTION
Record: QAMREC			
QAMPOLNAME	CHAR	7	Policy file name
MINDEP (18)	INT	2	Minimum DEP length by demographic group in months
MAXDEP (18)	INT	2	Maximum DEP length by demographic group in months
ACMLISTLEN	INT	2	Length of recommendation list passed to detailed assignment process

Detail of the Network Model. The network formulation of the QAM is detailed in the following sections. The arcs and nodes displayed in Figure B-2 are explained. Also, specific modeling features of the model are discussed.

Assignment Arcs. These arcs connect the supply group-month nodes (SG) and the MOS Cluster-month nodes (AH/AL/A4). The associated arc cost is a user-selected metric (see the Cost Criteria section) and is minimized in the problem's objective function. The AH, AL and A4 nodes act as collectors for recruits in the AFQT Categories I-IIIA (AH), AFQT Category IIIB (AL), and AFQT Category IV (A4). Each supply group-month node is only connected to the appropriate collector, as determined by the AFQT category associated with the supply group. The exclusion of some applicants to certain MOS is modeled by not connecting their associated supply group(s) to the restricted MOS Clusters (e.g. female supply group-month nodes are not connected to MOS Clusters containing male-only MOS).

MOS Cluster Requirements. This set of arcs transforms what would be a multicommodity problem into a single commodity formulation. Class requirements, including quality requirements, define monthly, fiscal and twelve-month MOS class goals for each MOS Cluster while still requiring that monthly and annual quality goals be met. In other words, the model forces a time-phased distribution of quality applicants to MOS Clusters, while meeting both MOS-specific goals and Army-wide quality goals.

Monthly goals for quality applicants are enforced through the use of a lower bound on the AH to AT arcs. The AT nodes sum the AH, AL and A4 nodes for each MOS Cluster-month. The lower bound on flow from the AT nodes ensures the minimum MOS Cluster class size requirements are met for that particular month, while the upper bound limits the maximum MOS Cluster size.

MOS Cluster Collector Nodes. In Figure B-2, for clarity's sake, only one type of collector node is shown. In the actual model, there are two types of collectors: the MT_k node, which collects the twelve-month demand for MOS Cluster k (as shown in Figure B-2), and the FY_k (Fiscal Year) node (not shown), which collects the fiscal-year demand for MOS Cluster k.

For classes starting in month x -- where month x is within the fiscal-year boundary (remember...AT nodes are both month and MOS Cluster specific) -- flow from the AT_{kx} node feeds the FY_k node.

For classes starting in month z -- where month z is beyond the fiscal-year boundary -- the AT_{kz} node feeds the MT_k node. Then, the FY_k node feeds into the MT_k node, with a lower and upper bound of the fiscal-year requirement for MOS Cluster k. This ensures the fiscal-year requirement will be met.

Finally, the MT_k node flows into the Super Sink (SK) with a lower and upper bound of the twelve-month requirement for MOS Cluster k. This will ensure the twelve-month requirement is met.

DEP Sink (DP) Node. The model does not define specific assignments beyond the end of the twelve-month planning horizon. However, recruits late in the planning horizon can accept a DEP length beyond the class months represented by the AT nodes. This is modeled as a direct flow from the SG_{ij} node to the DEP sink (DP). The cost on this arc is set to the maximum cost of all permissible MOS assignments for that SG node, so as to encourage filling seats within the planning horizon.

Super Sink (SK) Node. As in any network, total flow in must equal total flow out. To handle the exiting flow, the Super Sink (SK) is used. This node receives flow from the MT collector nodes for each MOS Cluster. In addition, any excess artificial supply from the Super Source (SS) flows into the Super Sink, with a cost of zero. Finally, the DEP sink feeds the Super Sink. Thus, the flow into the network (summation of all SG nodes and the Super Source) equals the flow out of the network (summation of all twelve-month demand (MT), DEP beyond the planning horizon, and unused artificial supply).

Additional modeling features were incorporated into the model to handle special cases (when supply is much greater than demand) and to goal toward results which alternatively could have been modeled as non-network constraints (distributing high school graduates equitably across MOS).

Quality Substitution. If the number of quality (AFQT Categories I-IIIA) recruits is insufficient to meet the quality requirement for any MOS Cluster in any given time period, the model is designed to permit AFQT Categories IIIB-IV recruits to fill quality class seats. This process, called quality substitution, permits the model to continue to a solution.

If quality supply is insufficient, the lower bound used to enforce the quality requirement (on the AU to AT arcs) could never be achieved. As a result, the optimizer would be unable to reach a solution; no usable output would be produced. Through substitution, the model can meet the quality requirement and continue. Any substitution performed will be traced and reported to the exception report.

The representation of the model in Figure B-2 must be expanded before further explanation can be attempted. A "snapshot" of the portion of the network where quality substituting is modeled is shown in Figure B-3. This figure depicts the actual design of the network. The AH nodes of Figure B-2 are in actuality split into two nodes: AG_{km} nodes and AU_{km} nodes.

Both the AG and AU nodes still collect quality recruits; the AG nodes collect quality recruits with a high school diploma or equivalent, whereas the AU nodes collect quality non-graduate recruits. (This differentiation is necessary to model graduate targets, explained in the next section.)

Substitution is modeled as follows: first, the AL_{km} nodes are connected to the respective AU_{km} nodes, with a very high cost and an upper bound equal to the quality requirement for that MOS Cluster / month. Likewise, the $A4_{km}$ nodes are connected to the AU_{km} nodes, with an even higher cost and the same upper bound. The cost structure is such that the model will use all quality recruits first, the AFQT Category IIIB recruits next (from AL nodes), then, as a last resort, the AFQT Category IV recruits (from A4 nodes). Since the upper bound on these substitution arcs is the quality mission, excessive substituting will be avoided.

High School Graduate Goaling. Once quality goals had been incorporated into the model, and testing had begun, we discovered an interesting phenomenon. The network was indeed meeting the MOS Cluster quality goals as desired; however, the graduate quality recruits were being disproportionately distributed across MOS Clusters. Upon examination, the reason for this occurrence became clear: the model had no way of differentiating between graduate and non-graduate quality recruits.

Although supply forecasts were broken to the graduate/non-graduate level of detail, both graduate and non-graduate SG_{ij} nodes fed into the AH quality collector node. Once this happened, flow out of the AH node had no associated education level. There was no mechanism within the model to prevent a MOS Cluster from being assigned only graduate quality recruits.

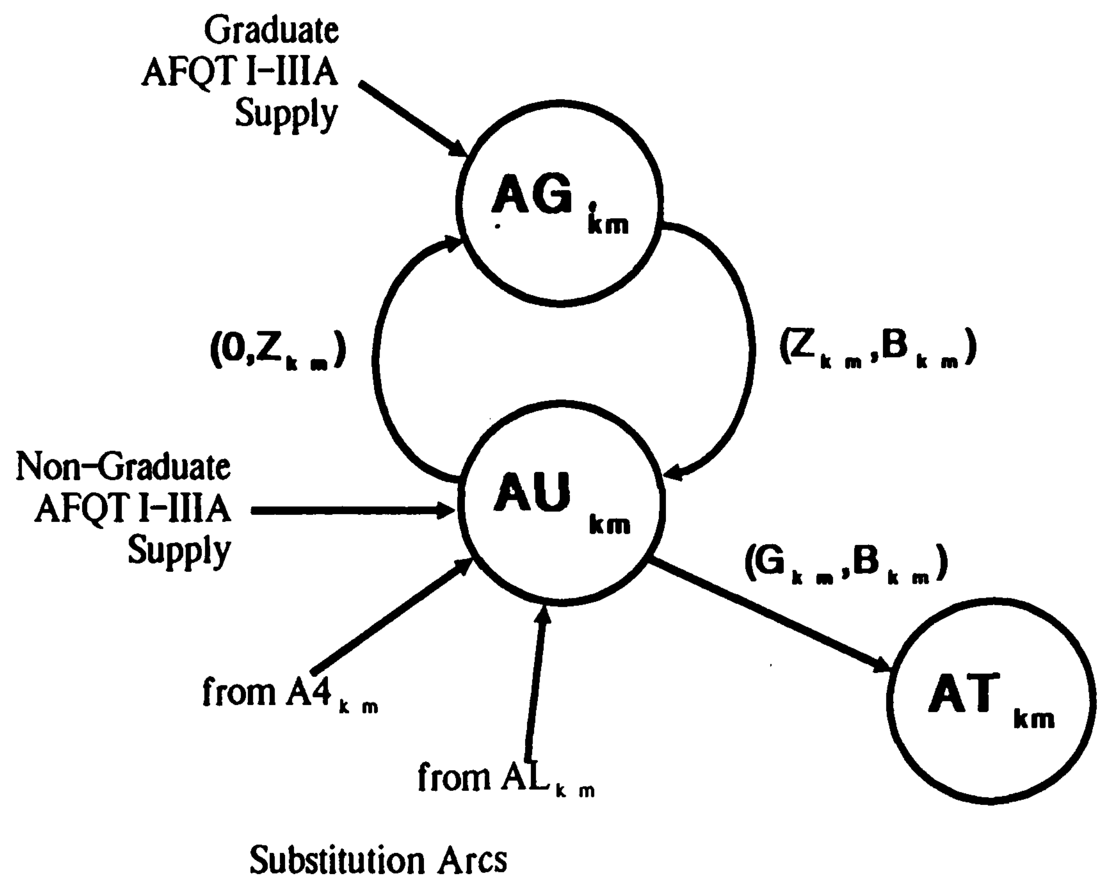

Figure B-3. Network Snapshot

This problem was circumvented by using graduate targets, calculated in the TRM, at the MOS Cluster level. The targets are applied in the AG_{km} and AU_{km} nodes shown in Figure B-3. Both nodes collect quality recruits. The only difference is that AG nodes collect high school graduates, whereas AU nodes do not.

Quality graduate SG_{ij} nodes now connect directly to the AG_{km} node; quality non-graduate now connect to the AU_{km} node. (In the diagram shown in Figure B-2, both flowed into the AH_{km} node.) The AU node is the only quality node connected to the AT_{km} collector, with a lower bound of the quality mission. To goal toward the graduate target (represented as Z_{km} in Figure B-3), the AG node is connected to the AU node with a lower bound of the graduate goal (Z_{km}) and a cost of zero.

An additional arc flows from the AU node to the AG node. This arc permits non-graduate substitution for graduate recruits, much the same as in quality substitution. Again, the costs are structured to ensure use of all graduates before substitution begins, and only non-graduates eligible for assignment to the MOS Cluster are substituted.

These quality targets guide the model toward a more equitable quality graduate distribution, without adversely affecting the quality goals themselves. A warning is written to the QAM exception report if any graduate goals are shorted; that is, if any non-graduates are used to fill graduate class seats.

<u>DEP Management</u>. DEP management is accomplished by use of the QAM policy editor. Minimum and maximum allowable DEP lengths are entered in the QAM policy editor by demographic group (Gender/Education/AFQT category). Assignment arcs in the model are then generated from the SG_{ij} nodes only to those MOS Cluster-month nodes (AG/AU/AL/A4) contained within that supply group's permissible DEP period.

<u>Escape Arcs</u>. As a proxy for rejection of marginal recruits, the model is designed to permit flow from the SG nodes directly to the Super Sink. Costs on these arcs ensure that any MOS Cluster assignment will be given over rejection. Escape arcs permit excess supply (usually in the AFQT Category IIIB and IV supply groups) to be rejected, without adversely affecting end strength or quality missions.

<u>Report Results of the Network Model</u>. All modes of the network formulation of the QAM will produce an exception report, four reports detailing the network solution itself, and data files for use in report generation. In addition, an ordered list of time-specific MOS Cluster recommendations is generated for use as guidance in the detailed classification process. A hard-copy version of this recommendation list is also generated.

QAM Exception Report. This report is written to an indexed sequential data file. The user-designated simulation name, iteration number representing the month of the simulation, and the module acronym "QAM" are used in building an unique, identifying key. All file processing problems causing abnormal termination of the model, and certain arc activity, are recorded in the exception report. Each of the following types of network arc activity appears in its own tabular structure on the exception report:

(1) Shortfalls in Quality Goals. This portion shows, by month, the shortfall in achieved quality by MOS Cluster. This indicates activity on the quality substitution arcs (AL-to-AU or A4-to-AU arcs in Figure B-3) was necessary to solve the network. Only those MOS Clusters experiencing a shortfall are reported.

(2) Shortfalls in Meeting MOS Requirements. This portion shows MOS Clusters for which monthly class requirements were not met. This indicates the Super Source had to be tapped to permit solution of the network. Again, only those MOS clusters experiencing a shortfall are reported.

(3) Deviation from Annual Requirements. This portion lists the desired fill, the achieved fill, and the percentage fill of the annual requirement for each MOS Cluster. Underfill is marked with an asterisk in the rightmost column. This indicates also that the Super Source had to be used in order to obtain a network solution.

If the network was able to meet all quality goals and all monthly and annual MOS requirements, these three reports will not be written to the exception report.

Descriptive Solution Reports. Four reports are sent directly to the printer file. These reports show detailed aspects of the solution:

(1) Demographic Flows. This report shows the number of each demographic type (defined by gender, education, and AFQT category) assigned to each MOS Cluster aggregated across the planning horizon.

(2) MOS Class Fill. This report shows details on each MOS cluster by month. Included are AFQT Categories I-IIIA, AFQT Categories IIIB-IV, and total assignments, class minimums and maximums, and the number of "artificial" assignments (from the Super Source) necessary to meet the class minimum. A value of "0" indicates a given MOS Cluster-month met its minimum fill without using the Super Source.

(3) Quality Goal. This report compares the desired percentage of quality recruits by MOS Cluster to the achieved percentage. Shortfalls are marked by an asterisk.

(4) Demographic DEP. This report shows the number of each demographic type (defined as in (1) above) assigned to a class beyond the planning horizon; that is, flowed to the DEP sink node.

Each of these reports will be generated regardless of the processing mode. Also, all reports are generated, whether the recruit supply pool was sufficient or not (use of the Super Source indicates insufficient supply). One additional report is produced in Classification runs: a hard-copy version of the ordered list containing the optimal guidance for the detailed allocation routines.

Data Files for Report Generators. Two types of data files are produced for use in report generation. The user-supplied EPAS run name, along with the iteration number (representing the month being processed), are used to uniquely identify the files produced. The report generator and its outputs will later in this appendix. The two types of data files produced by the QAM are:

(1) Assignment Flows. This data file contains counts of the number of assignments made in this iteration from Supply Group_i to MOS Cluster_j with a DEP period of k months. This file is used in generating the various metrics reports. The three dimensions (Supply Group, MOS Cluster, and DEP length) are required in calculating the various metric values.

(2) Aggregate Flows. This data file contains counts of all assignments made in this iteration, aggregated across all supply groups and all MOS Clusters. Two dimensions are necessary: Time-IN (the month in which the assignment was made) and Time-OUT (the month in which the class begins). This file is used in generating the Brick Chart as described below.

These data files are created regardless of the type of analysis (planning or classification) begin performed. As with other EPAS data files, the use of iteration number in identifying the files permits the user to restart a simulation, or rerun the same simulation.

Recommendation List for Use in Detailed Assignment. Optimal guidance is provided for the detailed classifications procedures, both the ACM and REQUEST, through ordered lists of alternative MOS assignments.

The QAM generates an optimal configuration for assigning Supply Groups to MOS Cluster / RSM combinations. Specific output from the optimization procedure includes the optimal solution and "reduced costs," i.e., the penalty for moving a single unit out of the optimal solution. A post-processor manipulates this output, generating a score for each MOS (not MOS Cluster) / RSM combination based on the reduced costs, the actual optimal solution, and specific MOS information, e.g., remaining annual requirement versus remaining class capacity.

The possible MOS/RSM for each Supply Group are then sorted on the computed score. The sorted list written to a file, shown in Table B-9, for use by the detailed allocation procedures.

Aggregate Allocation Model Formulation

The linear program forumulation, the Aggregate Allocation Module, has not been implemented at this time.

TABLE B-9
QAM ORDERED LIST FILE

NAME	TYPE	SIZE	DESCRIPTION
FNAME	CHAR	7	Unique name identifying the execution
ITERNUM	CHAR	2	Iteration number
FROMDATE	CHAR	4	Year/Month of the Supply Group's arrival
QAMAGID	CHAR	3	Supply Group identification number
QAMLISTNUM	CHAR	3	Recommendation's position on the ordered list
QAMSCORE	CHAR	4	The value computed by the post-processor
QAMCLUSTER	CHAR	3	The recommended MOS[4]
TODATE	CHAR	4	The Year/Month in which the recommended MOS training begins

4 Previously, the ordered list was by MOS Cluster rather than by MOS, hence the name "QAMCLUSTER" in the record.

GENERATE DETAILED ASSIGNMENT

The final requirement in generating optimal assignments is a detailed evaluation of assignments. Supporting this requirement requires a detailed Person-Job Match (PJM) process which matches single individuals to specific MOS/class start date combinations. In the planning mode, this requirement is met by the Applicant Classification Module (ACM). In a real-time operational mode, the Army's existing classification routines within REQUEST will be utilized. EPAS optimal guidance will be communicated to REQUEST through the REQUEST Interface Module (RIM).

The Applicant Classification Module

The basic functions required to support the ACM's sequential processing are depicted graphically in Figure B-4. These functions, described in more detail in the following sections, are:

(1) Define applicant arrivals. Determine the order in which applicants will "arrive" and be processed.

(2) Project optimum assignment. Evaluate each applicant against all positions available when the applicant "arrives" to determine the best possible match.

(3) Select job assignments. In reality, each individual applicant would simply tell the guidance counselor what job he will take, if any. Some means must be provided to simulate this recruit choice.

(4) Update job vacancies. Assuming an applicant accepts a job, a means must be provided to prevent future applicants from attempting to take the same position.

Define Applicant Arrivals. Each iteration in a simulation represents a distinct period of elapsed time within the overall time frame of the simulation. For example, if monthly iterations were being used, each iteration would simulate one complete Recruit Station Month (RSM). For the ACM to define applicant arrivals, several capabilities are required:

(1) A sample population from which applicant records can be selected.

(2) A simulation driver capable of choosing records from the sample population and passing them to the appropriate routines for further processing.

(3) A means of allowing the user to define simulation parameters to identify the sample populations, iteration periods, etc.

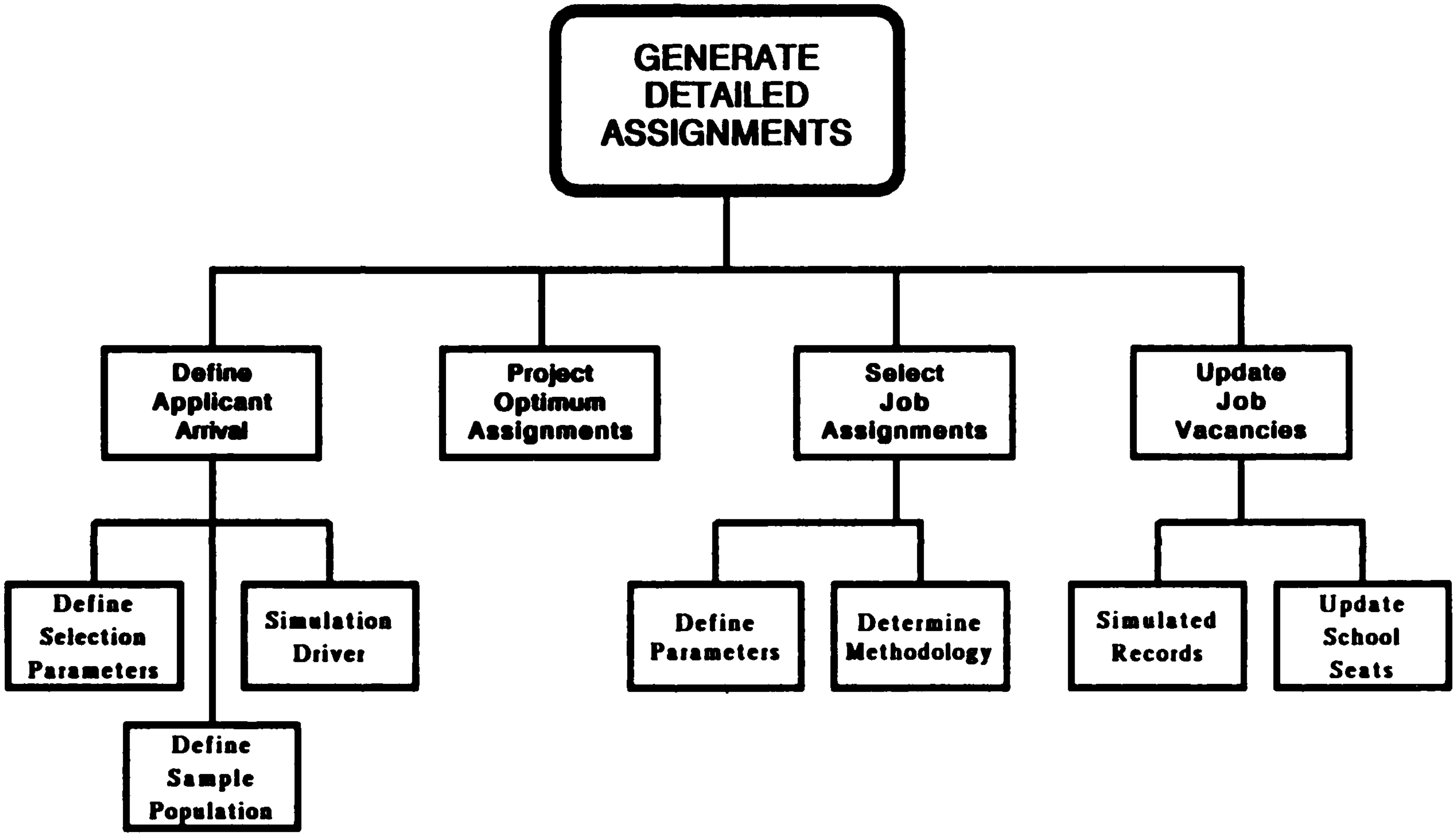

Figure B-4. Functional Requirements

Definition of Sample Population. It is necessary to have a predefined stream of applicants in order to run a simulation. Also, the user must be able to adjust the applicant stream to do policy analysis. To meet these requirements, two data files, known as the Primary Applicant File and the Secondary Applicant File, are generated from raw data supplied by USAREC.

The Primary Applicant File is generated directly from the raw data, while the Secondary Applicant File is generated as a subset of the Primary Applicant File. The information contained in the Primary Applicant File can be seen in Table B-10; the information contained in the Secondary Applicant File can be seen in Tables B-11, B-12 and B-13.

Primary Applicant File. Most of the information contained in the Primary Applicant File record description is self explanatory. The information is divided into five categories:

(1) File/Record Information. This data is used to access the information for any given applicant in the Secondary Applicant File. It includes the File Name and a Unique Record Identifier.

(2) Personal Information. This category contains data such as Gender, Citizenship, Race, Ethnic Group, Marital Status, Number of Dependents, and Date of Birth.

(3) Accession Information. This category includes information about the Date of Physical, Aptitude Scores, AFQT Category, Contract Data, Ship Date, Bonus Data and Term of Enlistment.

(4) Education Information. This category contains data about Education Certification, Year of Education and Level of Math and Science Achievement.

(5) Physical Profile. This category includes information about Physical Stamina, Upper and Lower Extremities, Hearing, Vision, Psychological Data, Height, Weight and Medical Failure Codes.

Secondary Applicant File. Most of the information contained this record is self explanatory. The information is divided into six categories:

(1) File Directory Information. This is needed to keep track of valid file names and number of files contained in the Secondary Applicant File.

(2) File/Record Information. This data is used to access the information for any given applicant in the Secondary Applicant File. It includes the File Name and a Unique Record Identifier.

TABLE B-10
RECORD STRUCTURE FOR THE PRIMARY APPLICANT FILE

NAME	TYPE	SIZE	DESCRIPTION
Record Name: PACC_REC			
REC_YEAR	CHAR	4	Recruit Year
REC_MONTH	CHAR	2	Recruit Month
DEMOGRAPH_KEY	CHAR	2	Demographic Number
RECORD_ID	CHAR	6	Unique Record Identifier
REC_WEEK	CHAR	2	Recruit Week
REC_WEEK_OF_MONTH	INT	2	Recruit Week of Month
RAW_SCORES (16)	INT	2	Raw Aptitude Scores
COMPOSITS (10)	INT	2	Composite Aptitude Score
DOOR_DATE	CHAR	6	Date of Physical Exam
SEX	CHAR	1	Gender
EDCERT	CHAR	1	Education Certification
MENTCAT	CHAR	2	AFQT Category
CONTRACT_STAT	CHAR	1	Contract Signed Flag
AFEESCD	CHAR	2	AFEES ID Code
FINAL_STATUS	CHAR	2	Shipped Status and DEP Status
CITIZ	CHAR	2	Citizenship Codes
RACE	CHAR	1	Racial Code
EGPCD	CHAR	1	Ethnic Group Code
CONTRACT_DATE	CHAR	6	Date Contract was Signed
SHIPED_DATE	CHAR	6	Date Accession Shipped
AFQTSCR	CHAR	2	AFQT Score
PHY_STAM	CHAR	1	Physical Stamina
UP_EXTREM	CHAR	1	Upper Extremities
LOW_EXTREM	CHAR	1	Lower Extremities
HEARING	CHAR	1	Hearing
EYES	CHAR	1	Vision
PSYCH	CHAR	1	Psychological
EXP_WEIGHT	CHAR	1	Weight Lift
HGT	CHAR	2	Height in Inches
WGT	CHAR	3	Weight in Pounds
MEDFAIL1	CHAR	2	Medical Failure Code 1
MEDFAIL2	CHAR	2	Medical Failure Code 2
MEDFAIL3	CHAR	2	Medical Failure Code 3
PROG1	CHAR	1	VEAP Option Flag
DESGOP	CHAR	1	Designated Option
TRENMOS	CHAR	3	Training/Enlistment MOS
WAIVER	CHAR	1	Waiver Type
ENLOP	CHAR	1	Enlistment Option Guaranteed
BONLVL	CHAR	1	Enlistment Level Bonus
NODEPR	CHAR	3	Reason for DEP Loss
MARST	CHAR	1	Marital Status

TABLE B-10 (Continued)
RECORD STRUCTURE FOR THE PRIMARY APPLICANT FILE

NAME	TYPE	SIZE	DESCRIPTION
NRDEP	CHAR	2	Number of Dependents
DOB	CHAR	6	Date of Birth
EDYRS	CHAR	2	Years of Education
DRIVER	CHAR	1	Drivers Licence Flag
MATH_LEV	CHAR	3	Level of Math Achievement
SCIENCE_LEV	CHAR	3	Level of Science Achievement
DATE_OF_AVAIL	CHAR	6	Date Available
PREF	CHAR	9	Preferences
REQ_BONUS	CHAR	1	Bonus Request Flag
COLLAGE_FUND	CHAR	1	VEAP Request Flag
ADD_TESTS	CHAR	40	Additional Tests
SCR_ADD_TEST	CHAR	30	Scores of Additional Tests
OPTION	CHAR	3	Enlistment Option
TESTID	CHAR	2	ASVAB Test Series
ENLTERM	CHAR	2	Term of Enlistment

TABLE B-11
INFORMATION RECORD STRUCTURE FOR THE SECONDARY APPLICANT FILE

NAME	TYPE	SIZE	DESCRIPTION
Record Name: SECOND_REC			
FNAME	CHAR	7	File Name
RECORD_ID	CHAR	6	Always set to 0
DEMOGRAPH_KEY	CHAR	2	Always set to 0
REC_YEAR	INT	2	Always set to 0
REC_WEEK	INT	2	Always set to 0
YEAR_TOT (25)	INT	4	Yearly Totals
DEM_TOTALS (60)	INT	2	Demographic Totals
FILLER	CHAR	17	Alignment Characters

TABLE B-12
DATA RECORD STRUCTURE FOR THE SECONDARY APPLICANT FILE

NAME	TYPE	SIZE	DESCRIPTION
Record Name: ACC_REC			
FNAME	CHAR	7	File Name
RECORD_ID	CHAR	6	Unique Record Identifier
REC_MONTH	CHAR	2	Recruit Month
DEMOGRAPH_KEY	CHAR	2	Demographic Number
FNAME2	CHAR	7	Repeat of File Name
REC_YEAR	CHAR	4	Recruit Year
REC_WEEK	CHAR	2	Recruit Week
DOOR_DATE	CHAR	6	Date of Physical Exam
REC_WEEK_OF_MONTH	INT	2	Recruit Week of Month
RAW_SCORES (16)	INT	2	Raw Aptitude Scores
COMPOSITS (10)	INT	2	Composite Aptitude Score
SEX	CHAR	1	Gender
EDCERT	CHAR	1	Education Certification
MENTCAT	CHAR	2	AFQT Category
CONTRACT_STAT	CHAR	1	Contract Signed Flag
AFEESCD	CHAR	2	AFEES ID Code
FINAL_STATUS	CHAR	2	Shipped Status and DEP Status
CITIZ	CHAR	2	Citizenship Codes
RACE	CHAR	1	Racial Code
EGPCD	CHAR	1	Ethnic Group Code
CONTRACT_DATE	CHAR	6	Date Contract was Signed
SHIPED_DATE	CHAR	6	Date Accession Shipped

TABLE B-12 (Continued)
DATA RECORD STRUCTURE FOR THE SECONDARY APPLICANT FILE

NAME	TYPE	SIZE	DESCRIPTION
AFQTSCR	CHAR	2	AFQT Score
PHY_STAM	CHAR	1	Physical Stamina
UP_EXTREM	CHAR	1	Upper Extremities
LOW_EXTREM	CHAR	1	Lower Extremities
HEARING	CHAR	1	Hearing
EYES	CHAR	1	Vision
PSYCH	CHAR	1	Psychological
EXP_WEIGHT	CHAR	1	Weight Lift
HGT	CHAR	2	Height in Inches
WGT	CHAR	3	Weight in Pounds
MEDFAIL1	CHAR	2	Medical Failure Code 1
MEDFAIL2	CHAR	2	Medical Failure Code 2
MEDFAIL3	CHAR	2	Medical Failure Code 3
PROG1	CHAR	1	VEAP Option Flag
DESGOP	CHAR	1	Designated Option
TRENMOS	CHAR	3	Training/Enlistment MOS
WAIVER	CHAR	1	Waiver Type
ENLOP	CHAR	1	Enlistment Option Guaranteed
BONLVL	CHAR	1	Enlistment Level Bonus
NODEPR	CHAR	3	Reason for DEP Loss
MARST	CHAR	1	Marital Status
NRDEP	CHAR	2	Number of Dependents
DOB	CHAR	6	Date of Birth
EDYRS	CHAR	2	Years of Education
DRIVER	CHAR	1	Drivers Licence Flag
MATH_LEV	CHAR	3	Level of Math Achievement
SCIENCE_LEV	CHAR	3	Level of Science Achievement
DATE_OF_AVAIL	CHAR	6	Date Available
PREF	CHAR	9	Preferences
REQ_BONUS	CHAR	1	Bonus Request Flag
COLLAGE_FUND	CHAR	1	VEAP Request Flag
ADD_TESTS	CHAR	40	Additional Tests
SCR_ADD_TEST	CHAR	30	Scores of Additional Tests
OPTION	CHAR	3	Enlistment Option
TESTID	CHAR	2	ASVAB Test Series
ENLTERM	CHAR	2	Term of Enlistment

(3) Personal Information. This category contains data such as Gender, Citizenship, Race, Ethnic Group, Marital Status, Number of Dependents, and Date of Birth.

(4) Accession Information. This category includes information about the Date of Physical, Aptitude Scores, AFQT Category, Contract Date, Ship Date, Bonus Data and Term of Enlistment.

(5) Education Information. This category contains data about Education Certification, Year of Education and Level of Math and Science Achievement.

(6) Physical Profile. This category includes information about Physical Stamina, Upper and Lower Extremities, Hearing, Vision, Psychological Data, Height, Weight and Medical Failure Codes.

To provide an appropriate user interface, an editor has been developed for the Secondary Applicant File generation process and a method has been provided to monitor the execution status.

The Secondary Applicant File Editor. This editor has limited functionality when compared to the other editors in EPAS, since it will only allow the user to create new files. Due to the volume of data to be produced, the actual file generation takes place in batch mode. A communication file, the Applicant Communication File, must be used to communicate between the on-line editor and batch file generator. The data contained in the Applicant Communication File is listed in Tables B-13 and B-14.

Most of the information contained in the Applicant Communication File is self explanatory. The information can be divided into three categories:

(1) File/Record Information. This data is used to access the communications information for any given Secondary Applicant File to be generated. It includes the File Name, Fiscal Year and Month.

(2) Demographic Information. The area includes information on the Demographics that need to be included in the Secondary Applicant File and the Distribution of the Demographics by Month.

(3) Mission Information. This area includes information on Recruit missions for the current month by recruit type.

Batch Submittal. The requirements for batch submittal were handled differently for each computer system due to operation system restrictions. On the WICAT system, the Pascal code allowed direct

TABLE B-13
DATA RECORD STRUCTURE FOR APPLICANT STREAM GENERATOR
COMMUNICATION FILE

NAME	TYPE	SIZE	DESCRIPTION
Record Name: APPCOM_REC			
FNAME	CHAR	7	File Name
YEAR	CHAR	4	Record Year
MONTH	CHAR	2	Record Month
FILLER	CHAR	1	Alignment Characters
GOALS (2)	INT	2	Total goals for month by recruit type
DISTRIBUTION (60)	REAL	4	Distribution of demographic groups for month

TABLE B-14
DEMOGRAPHIC TREE RECORD STRUCTURE
FOR APPLICANT STREAM GENERATOR COMMUNICATION FILE

NAME	TYPE	SIZE	DESCRIPTION
Record Name: APPCOM_TREE			
FNAME	CHAR	7	File Name
SIX_BLANKS	CHAR	6	Six Blanks
FILLER	CHAR	1	Alignment Character
TRACE	INT	2	Trace Flag
NUM_MONTHS	INT	2	Number of months of data to be generated
TREE (60)	INT	2	Flags of Demographics that have been selected
YYYY (60)	INT	2	Alignment Characters

access to the operation system utilities. The system was coded to directly initiate another job from the program.

For the IBM system at NIH, operating under the MVS/XA operating system, the submittal of batch jobs occurs after the on-line system has completed executing. A CLIST has been developed which executes the on-line system and, at on-line system termination, checks a return code to determine if any batch runs are to be performed. If so, it reads an interface file which specifies the type of batch job (simulation / optimization, reports, metric generation, applicant / contractee file generation) and the Run File name. Based on this information, the CLIST edits an appropriate control file containing JCL to insert the run file name and job card information. The edited file is then submitted for batch execution.

A batch control program has been developed for each of the batch operations. This program will read the Run File name from the parameter (PARM) statement in the execution JCL. All other information regarding the execution of the system is contained in the Run File record.

Execution Status Monitoring. To provide feedback to the user regarding the execution of his Secondary Applicant File generation run, an execution status review module has been added to the system. This module provides up-to-date monitoring of the generation process and displays all current exception reports that have been generated for the run. A list of the possible exception reports generated by the batch portion of the Secondary Applicant File generator can be seen in Table B-15.

Simulation Driver. A special driver routine is required for the ACM to chose applicants for further processing. This driver is simply a "shell" which selects records from the sample population, forwards them for further processing, and returns control to the Process Test System (PTS) when no further records are to be processed for the current iteration.

The driver selects records by constructing a key based on the current iteration and the desired arrival sequence. If, for example, monthly iterations are being performed and RSM October is being simulated, sample population applicant records with an arrival date (door date) in RSM October will be processed. The door date is used as the second part of the key. This allows records to be processed in the same order in which they were historically processed.

Parameter Inputs. The discussion of the various input parameters required for controlling the simulation driver is deferred to a later section, ACM Input. This will allow the discussion of all ACM-associated input to occur at a single location.

TABLE B-15
EXCEPTION REPORT MESSAGES FROM THE
SECONDARY APPLICANT FILE GENERATOR

(1) 75% level reached for demogroup TT in month PP.
(2) Aborting: Unable to find record in APPCOM file.
(3) Aborting: Unable to open/create files.
(4) Aborting: Unable to open APPCOM file.
(5) Aborting: Unable to open STDDIST file.
(6) Begin building the Secondary Applicant File.
(7) Beginning file open/create sequence.
(8) Error finding valid accession data due to invalid data.
(9) Error: Unable to find primary record.
(10) Generating secondary file SS.
(11) No primary file records for demogroup TT in month PP.
(12) No requirements specified for month PP.
(13) Recycling applicants for demogroup TT in month PP.
(14) Secondary file completed: RR records generated.
(15) Secondary file creation canceled: No acceptable recruits found on primary file.
(16) Secondary file creation canceled: Program aborted.
(17) Starting the PP iteration out of QQ.
(18) The secondary file was aborted in month PP.
(19) Unable to open ACCESS file.
(20) Unable to open ACCSCR file.
(21) Unable to open secondary file.

where:
PP - Current iteration number.
QQ - Number of iterations that the file is being generated for.
RR - Number of records generated for the secondary file.
SS - Name of secondary file being created.
TT - Number indicating demographic group.

Project Optimum Assignments. The next functional capability required to perform sequential processing is to evaluate potential person/job matches and recommend the best match. This must be done be taking into account both the applicant's abilities and interests and the Army's requirements.

The ACM's methodology was chosen to be a simple linear weighting of the selected factors. Individual factors could be defined and developed as "black boxes," that is, highly modularized mathematical definitions, with varying weights being applied to determine the impact of the factor in relationship with the other factors being used.

The ACM's factors were selected to meet the functional requirements of EPAS. The factors, therefore, are based on a survey of existing systems (described in Appendix A), experience of knowledgable users, and the overall design philosophy of EPAS. The factors currently included in the ACM are:

OAM Ordered List. This factor is incumbent in the design philosophy of EPAS and is unique to the system. It is this factor, generated by the network optimization routines, that provides the ACM with its "look ahead" capability, enabling it to develop detailed solutions consistent with the globally optimal solution. The reduced cost technique employed to implement this factor has been described in Appendix A.

Predicted Job Performance. This factor provides a detailed assessment of the individual's probable performance in an MOS. The majority of analysis performed to date has been in this area and several options are available. While only one option can be selected for inclusion in the scoring routines, the other predictors are computed and are available for the report generators. The available options are:

(1) Aptitude Area score. The applicant's Aptitude Area Composite score is used directly. The user has the ability to select different means of formulating the composite score from among:

(a) New Composites, 1980 Norm. (This, effectively, is what is done in the current system (MMM).) The composite formulations are as developed by Project A.

(b) New Composites, 1944 Norm. Project A composite formulations are used, but are normalized to the WWII (1944) base population.

(c) Old Composites, 1980 Norm. Pre-Project A composite formulations are used with the 1980 population.

(d) Old Composites, 1944 Norm. Pre-Project A composite formulations are used with the WWII (1944) base population.

(2) Predicted SQT Scores. SQT scores are predicted as functions of the ASVAB subtest scores.

(3) Relative MOS Utility. The relative utility of an MOS assignment is used.

(4) Project A Composite Measure. This is a partially implemented technique based on the work being performed in Project A to develop novel means of MOS classification. Project A's prime contractor, the American Institute for Research (AIR), has defined five new measures (Briefing given to Scientific Advisory Group, September, 1986).

The ACM's Project A Composite job performance measure is an AIR-defined composite of these five measures. It is only partially implemented at this time as the measures are based on scores obtained from a newly defined battery of tests. These tests are not currently given to the general applicant population; therefore, only a specially defined test population can be used in the simulations at this time. The five measures are:

(a) Task Proficiency: General or common skills -- the individual's ability to perform the "soldiering" skills common to all MOS.

(b) Task Proficiency: MOS (Job) specific core technical skills -- the individual's ability to perform the skills unique to an MOS.

(c) Peer Leadership, Effort, and Self Development -- the individual's quality to successfully assume leadership roles.

(d) Maintaining Personal Discipline -- the individual's ability to perform duties without undue oversight or disciplinary problems.

(e) Military Bearing/Appearance -- the individual's propensity to maintain suitable fitness and proper military appearance and bearing.

(5) Project A TKS Scores. This option is also based on the new measures defined by Project A. AIR's analysis has shown that, of the five measures, only the MOS (Job) specific core technical skill (TKS) measure provides MOS differentiability. This option allows the ACM to use the TKS measure independently to select from among the available MOS. As with the Project A Composite measure, this measure requires a specialized, pretested population and can only be simulated with this population at the present time.

Predicted Retention Behavior. The next ACM scoring factor predicts the individual's probability of completing the first term of enlistment in each MOS. The ARI-developed MOS-based attrition prediction equations are used for this factor.

Management Potential. This factor provides the means of assessing the individual's promotion potential and probability of successfully assuming a leadership/management role. Current implementation uses the Army's assumption that AFQT Category I-IIIA personnel will make desirable leaders; the module computes the factor score based solely on achieving the specified quality target for an MOS. A two-part linear equation is used to generate the score based on how far the MOS quality fill is above or below the mission.

Affirmative Action/Equal Opportunity Missions. This factor evaluates the success with which AA/EO missions are being met. The currently implemented routine uses two parts: one for evaluating racial missions, the other for gender missions. In both cases, two-part linear equations are used to evaluate the scores based on current fill versus mission fill. The two scores are then combined using linear weights.

Reenlistment Potential. This factor defines the probability of the individual reenlisting for the career force at the end of the first term of enlistment. At present, this factor is not implemented; rather, a dummy routine is present to provide a location for possible future implementation.

Probable Training Success. This factor predicts the probability of the individual successfully completing the skill training associated with the MOS. As with Reenlistment Potential, this factor is not currently implemented; a dummy routine provides a location for possible future implementation.

Time to Fill. This factor computes a score based on the system's flexibility to fill the remaining annual requirement. The maximum number of school seats for an MOS often exceeds the annual program for that MOS to provide flexibility in accession distributions. This ACM factor monitors the remaining requirement to fill the annual program and the remaining [total] school seat capacity to ensure that the annual program is met.

Class Training Demand. This factor computes a score based on filling specific classes for an MOS. The routine uses step functions based on:

(1) Difficulty of Fill. MOS are divided into three categories: hard to fill, easy to fill, and other. The need to fill a specific class will be adjusted to ensure that the demands of hard to fill MOS are met.

(2) Time Remaining. The time remaining until the class begins. The less time remaining to meet the class missions, the higher the score.

(3) Current Fill. The ACM evaluates the current fill of the class and adjusts the score based in relationship to the minimal and optimal levels. [Once the maximum fill level is achieved, the class is "closed" by the model.] Each class has three fill levels defined:

(a) Minimum Fill -- the number of recruits necessary for the class to meet.

(b) Optimal Fill -- the desired number of recruits in the class.

(c) Maximum Fill -- the largest number of recruits which can be assigned to the class.

Several of the above factors provide the user with options. Some form of input is required, therefore, to enable the user to specify exactly what form the measure is to take for the simulation to be performed. The discussion of the various input parameters required for defining the specific measures is deferred to a later section, ACM Input. This will allow the discussion of all ACM-associated input to occur at a single location.

Application of Policy Guidelines. When an applicant is presented to the scoring routines (by the simulation driver), the ACM first determines with which Supply Group the applicant is associated. The ordered list associated with that Supply Group is then used to determine the order in which MOS/Start Date combinations are to be evaluated. Thus the aggregate allocation routine both determine the order in which the MOS are to be evaluated and provide a direct input to the payoff score which is generated.

Simulations have shown, however, that some of the recommendations generated by the network model, while legitimate in an aggregate sense, are not possible when applied to individuals. For example, Supply Groups are defined based on the average abilities of the member populations. An individual within a Supply Group may have a particular Aptitude Area Composite score well below the mean of the group and, thus, be ineligible for an MOS for which the Supply Group, on the average, is eligible. Similarly, the network may recommend allocation to a class which, when processed sequentially, has been filled with earlier applicants and is no longer available.

A critical requirement in any skill allocation algorithm is ensuring that any restrictions governing the skills are enforced. The ACM, therefore, examines each MOS/Start Date recommended by the network for the individual and, if necessary, eliminates it from consideration.

The ACM utilizes two techniques to meet the requirement of enforcing individual restrictions. One technique is associated with skill restrictions, the other with skill goals.

Restrictions. When dealing with skill restrictions, the ACM is rigorous in enforcing policy guidelines. When a potential MOS is identified, the ACM first checks the individual's qualifications against the stated minimum requirements for the MOS. Failure to meet any of the minimum qualifications will result in the person being identified as ineligible for that skill. If, for example, the skill requires an Aptitude Area Composite score of 95 and the individual has a 94, the individual will not be allowed into the skill.

Another arena in which rigorous enforcement occurs is with annual program fill. The ACM will not overfill an annual program: once an MOS has sufficient recruits to meet 100% of its program, the MOS is turned off to future applicants. [Note: this does not prevent records from being delayed (DEPed) into the next recruit year in that skill.]

Goals. These are areas where the Army has specified desired missions, but the model has the flexibility to adjust actual achievements as required. An example of this type of mission is the percentage of an MOS's accessions to be filled by quality personnel. Rather than shortfall the annual program, the ACM will fill with AFQT Category IIIBs (or IVs if necessary). When this type of substitution occurs is a function of several factors such as time remaining to fill the skill, difficulty of filling the skill, etc.

Select Job Assignment. The next functional requirement for short range assignments is the means to emulate an individual applicant's choosing jobs from the list of recommendations. This requirement arises from the need to consummate processing for one applicant before the next applicant is entered into the system; which, in turn, is necessary to ensure that multiple applicant's are not mistakenly allocated to the same position.

Two, conflicting, capabilities are required to support this functional requirement:

(1) The capability to always have the system analyst define the job to be selected independently from [simulated] applicant choice. This capability eliminates random influences caused by applicant choice, allowing the analyst to evaluate the impact of policy alternatives.

(2) The capability to simulate applicant choice, that is, the applicant has the freedom to select any of the offered jobs with little to no influence by the Army. This capability provides the ability to test the robustness of policy alternatives, allowing the EPAS user to determine whether or not

the policy alternative would be unduly affected by applicant choices.

The EPAS prototype's implementation provides the system's analyst with five options of how job selection is to be performed. These are:

(1) The same relative job is always selected. This is the standard option, with the first job on the list always being selected (although position on the list -- second, third, n^{th} -- can be specified). This option is best for determining the impact of policy options as the results of the simulation are not affected by random selection criteria. This is the only option providing the analyst with explicit control over the selected assignment; the four remaining options use some type of random selection.

(2) The second option uses a (approximately) normally distributed random numbers to select one of the first fifteen jobs on the list.

(3) The third option is similar to the second in that it randomly selects one of the first fifteen jobs based on a normal distribution. It differs in that it also provides a 40% possibility that the applicant may reject all of the jobs on the list.

(4) The fourth option uses uniformly distributed random numbers to select from any job on the list of available positions.

(5) The fifth option also uses uniformly distributed random numbers to select a job, but the analyst has the additional ability of defining the number of jobs from which the selection may be made as a function of the type of applicant. For example, male, AFQT Category I-IIIA, high school graduates may be allowed to select any available jobs, while male, AFQT Category IIIB, non-high school graduates might be limited to the first ten jobs on the list.

Once again, it is clear that some form of input control is required to enable the user to define the precise parameters to be used in a simulation. The discussion of these input parameters is deferred to a later section, <u>ACM Input</u>, to allow the discussion of all ACM-associated input to occur at a single location.

<u>Update Job Vacancies</u>. The fourth, and final, function necessary to directly support the sequential processing is the ability to update job vacancy indicators or, more precisely, to indicate when previously vacant positions have been filled by an accession. This capability is required for two reasons:

(1) Most obviously, positions must be somehow marked as no longer available to prevent multiple filling of the same position.

(2) Secondly, the ACM must be able to track the type of fill which has occurred, e.g., how many quality accessions, for each MOS. This capability is required to provide the information needed to compute appropriate values for the factors being used to generate the applicant's PJM score.

This requirement is addressed by maintaining a special copy of a school seat requirement file. Each time an applicant is predicted to accept an MOS, appropriate counters are updated to reflect the characteristics of the individual and to decrement the required fill for the MOS. The information contained in the School Seat File was depicted previously in Table B-3.

ACM Input. The preceding sections have demonstrated the need for several types of parametric inputs to support the generation of optimal short range assignments. In addition, a second type of input will also be required to support the ACM; specifically, definitions of the various files which provide the information, such as quality missions, needed by the sequential processor.

Policy Parameters. Definition of the ACM policy parameters is accomplished through an ACM Policy Editor. A series of panels in the PTS driver routines was developed to allow EPAS users to quickly and easily modify the parameters to be employed for any given simulation.

A named policy record is associated with each set of policy parameters as the set is defined; this named record, the ACM Policy Record, is then saved in a file for future reference. The user must first declare which ACM Policy Record is to be utilized. The editor routines will then prompt for the specific parameters which are required for the ACM through a series of control panels. The panels which are presented, and the parameters which are input are:

(1) Execution Parameters. The first panel request a series of parameters which control the execution in general. These parameters include:

(a) MOS Worth Definitions. The name of the file containing the data for determining the relative worth of specific MOS assignments.

(b) SQT Coefficients. The name of the file containing the ridge regression coefficients to be used in predicting the SQT score for individual MOS.

(c) Attrition Probabilities. The name of the file containing the data for computing first term attrition probabilities.

(d) Initial Seed Value. If one of the applicant choice options is selected, random numbers are required for the ACM's simulation. The analyst has the ability to alter the initial value used by the computer's random number generator, thus altering the sequence of random numbers. This will provide the ability to verify the robustness of the simulated solutions.

(e) Max. Applicants/Iteration. This parameter provides the ability to limit the number of accession records to be processed during a single iteration, providing the capability to check system modifications in minimum execution time.

(f) Max. Job Matches/Applicant. This parameter can be used to limit the number of possible job opportunities that will be computed for a single individual.

(g) Job Performance Option. This parameter defines which of the type of measure is to be used in predicting job performance. The currently available options, described in detail above, are:

(i) Aptitude Area Score.
(ii) Predicted SQT Score.
(iii) Relative MOS Worth.
(iv) Project A Composite Measure
(v) Project A Technical Skill Measure.

(2) Delayed Entry Program (DEP). The second panel requests information to be used in controlling the length of the DEP[5]. This panel defines the maximum length of time (in months) that individuals will be allowed to delay their entry. The ACM allows the analyst to define these limits separately based on gender, education, and AFQT Category.

(3) Job Selection Method. The third panel provides the capability to define the technique the ACM is to use to select jobs from the list of alternatives, i.e., how to simulate applicant choice. As was previously discussed, several methods of job selection are available. The method to be used can be defined separately based on gender, education, and AFQT category. Available options are:

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5 In addition to specifying the maximum length of the DEP, the Army also has the ability to specify specific points within the maximum DEP in which delayed entry is, or is not, possible. This policy, called the RUDEP, is not currently implemented in the ACM.

(a) Each individual will select the n^{th} job on the list, where "n" can range from one to the number of jobs identified.

(b) The ACM will randomly choose a job, using a normal distribution, from the list of available jobs.

(c) The ACM will randomly choose a job, using a normal distribution, from the list of available jobs assuming a 40% probability of rejecting all jobs on the list.

(d) The ACM will randomly choose a job, using a uniform distribution, from the list of jobs available.

(e) The ACM will randomly choose a job, using a uniform distribution, from a maximum of "m" jobs.

(4) Scoring Routine Weights. The ACM determines the best job match, as described above, by linearly combining a series of individual scoring factors. The fourth, and final, panel is the means through which the user defines the relative weights to be associated with each of the criteria.

File Definitions. The second type of input for the ACM is the names of the many files required to define the policies, options, limitations, etc. within which the model is to function. Each of these files will be defined in the simulation's Run Record. The files to be defined are:

(1) Accessions File. This file defines the sample population to be used by the simulation.

(2) AAMMP Limits File. The Active Army Military Manpower Program (AAMMP) defines the number of personnel who are to be accessed in any given month. This file provides this information to the ACM.

(3) Cluster Definition File. This file defines the currently active MOS and the cluster with which they are associated.

(4) Composite Definition File. This file defines the technique to be used in generating the Aptitude Area Composite scores from the ASVAB subtest scores.

(5) MOS Information File. This file contains descriptive information for each of the currently active MOS. This includes such data as minimum cut scores, quality missions, entry restrictions, etc.

(6) QAM Input File. This file is used to pass the QAM's global recommendations to the ACM for detailed processing.

(7) School Seat File. This file defines the number of school seats actually available for each MOS. It includes information such as start date, maximum capacity, etc.

ACM Input. The need to update the School Seat file to reflect the current status of MOS requirements has already been identified as an output requirement. A second type of output is implicitly required from the short range assignment routines; namely, a tracking of each individual processed by the ACM. This second type of output is necessary to allow statistical evaluation of the results of the simulations.

School Seat Updates. When operating in a planning analysis mode, EPAS cannot, for obvious reasons, update the actual file of school seat requirements. A substitute school seat file is created, therefore, by making a copy of, or extracting from, the actual master file.

The ACM loads the school seat information into internal arrays and updates the arrays as the simulation progresses. At the end of each iteration, a new copy of the substitute file is created; the original input file is not altered. This allows identification and analysis of the specific changes made during each iteration.

School Seat Policy File. The information contained in this file was shown in Table B-3.

School Seat File Editor. Since supporting analysis of alternative accession plans requires providing the user with the ability to generate alternative school seat plans, an editing capability was also required for the School Seat File. The School Seat File editor supports the following functions:

(1) Creation of a new School Seat File using an existing file as the starting point for the new file.

(2) Modification of an existing School Seat File; this includes the creation and deletion of class information for the MOS to be used in the simulation.

(3) Deletion of School Seat Files.

(4) Reviewing of School Seat File information (read only operation - no modifications are allowed).

The editing capabilities for the School Seat File allow the user to create new MOS records or alter existing records. Both provide the ability to perform policy analysis, allowing the user to selectively define new system requirements and/or to alter the historical state to determine the affect of significant changes in historical accession patterns.

If a new MOS is to be created, the user must first define the new MOS in the MOS History File. This definition is necessary to give EPAS the necessary transitional definitions. The School Seat Policy Editor will verify the existence of the new MOS in the MOS History File and, if it is not present, will not allow the user to proceed until the proper linkages have been defined.

Data elements within the School Seat record which can be modified, and the implications of their modification, are:

(1) Class Start Date. The class start dates define the necessary arrival distribution of accessions. Altering the dates for some MOS will allow the user to determine the impact which such changes would have on the Army's overall ability to meet its annual goals, both for the specific MOS which are altered and force wide.

(2) Capacities. The School Seat record has three capacity fields: minimum fill, optimal fill and maximum fill. Altering these fields will, like altering the start dates, allow the user to access the overall impact of changing the accessions program part way through the accession year.

(3) Current Fills. The School Seat data record has several fields, CLASS_FILL, COHORT_FILL, MINORITY_CONT, METRICS, which define the current fills of the classes contained in the record. Since each of these fields define actions which have already been accomplished, altering any of them has the affect of "changing history." Clearly, any such changes should only be used for policy analysis simulations designed to determine the impact of sudden changes in the actual accessions available.

(4) Metric Fields. The School Seat File maintains the average metric scores, that is, Aptitude Area, Predicted SQT, Relative Worth, Predicted Attrition, and DEP/Attrition Savings, for personnel who have already been contracted. Altering any of these values has the affect, like changing the current fills, of changing history and is available only for simulating advanced "what if" conditions.

Statistical Output. The second type of output is a trace record giving summary information about the scores generated for the applicant. This type of output is necessary to allow analysis of the transactions generated by EPAS.

The format for the records with this output is given in Table B-16. Key variables within the record are:

TABLE B-16
ACM STATISTICAL OUTPUT RECORD

NAME	TYPE	SIZE	DESCRIPTION
FNAME	CHAR	7	Simulation Name
ITERNUM	CHAR	2	Simulation period for which data applies
APPLICANTID	CHAR	9	Unique record ID identifying the applicant
PJMMOS	CHAR	3	The MOS which was selected
PJMATT	INT	4	The predicted attrition associated with the PJMMOS
PJMSQT	INT	4	The predicted SQT score associated with the PJMMOS
PJMWRT	INT	4	The relative utility associated with the PJMMOS
PJMAA	INT	2	The Aptitude Area Composite score associated with the PJMMOS
PJMSCORE	INT	2	The ACM-generated score for the PJMMOS
PJMRANKING	INT	2	The relative position of the PJMMOS on the ordered list of recommendations
PJMPRIORITY	INT	2	The priority of the PJMMOS
APPGPID	INT	2	The Supply Group with which this applicant is associated
PJMMOSCLUSTER	INT	2	The MOS Cluster with which the PJMMOS is associated
T25SCORES (25)	INT	2	The ACM-generated scores for the first 25 recommendations
T25MOS (25)	CHAR	3	The MOS associated with the first 25 ACM recommendations
T25DATES (25)	CHAR	6	The class start dates for the first 25 ACM recommendations
CONTRACTDATE	CHAR	6	The contract date
PJMCLASSCODE	CHAR	1	The class identification code for PJMMOS
PJMSTARTDATE	CHAR	6	The starting date for PJMMOS
PJMOPTIONS(10)	CHAR	2	List of contract options selected by the applicant
PJMENLISTTERM	CHAR	3	The term of enlistment for the contract (in years)

(1) FNAME. This variable is used to distinguish between different simulations or alternatives. This allows the user to execute multiple simulations and save the results for subsequent analysis.

(2) ITERNUM. Separate output files are created for each iteration, i.e., each time period, for the simulations. This provides the ability to restart from a partial simulation as well as enabling detailed analysis on an iteration by iteration basis.

(3) PJMMOS. The MOS for which a contract was signed. (This field will contain "NON" if no contract was signed.) All variable names which begin with "PJM..." pertain to this specific MOS.

(4) PJMSCORE. If the applicant being processed signs a contract, this field contains the ACM-generated PJM score for the MOS/class which was selected. If the applicant did not sign a contract, this field will contain a negative number indicating the reason that no contract was issued. The current code values this field may contain are:

   a. -1 -- No Jobs. The ACM was unable to find any jobs for which the applicant was qualified.

   b. -3 -- Bad Supply Group. An error was generated when determining the supply group with which the applicant should be associated.

   c. -4 -- ASVAB Scores. The applicant had invalid ASVAB scores in his/her record and could not be processed.

   d. -5 -- Applicant Choice. The applicant elected not to accept any of the jobs which were available.

(5) PJMRANKING. This is the relative ranking of the PJMMOS on the ordered list which was generated by the ACM. If no contract was signed, this field will contain the same value as is found in PJMSCORE.

REQUEST Interface Module

The REQUEST Interface Module is under investigation and has not been implemented at this time.

REPORT RESULTS

The reports display the results of EPAS assignment analyses and plans. There are presently fourteen reports that the user can select. Within these reports the user has the ability to select options such as:

(1) Iteration(s). A representation of the interval of time that EPAS is simulating. The current intervals are weekly, monthly, and yearly.

(2) Demographic Grouping. This grouping is comprised of gender, level of education, and AFQT category.

(3) Performance Measures. The utilities of measure that are used in EPAS. There are currently four of them, attrition, average aptitude area score, SQT, and worth.

(4) Level of Detail. This option is available on MOS aggregation to cluster and MOS.

<u>Report Metrics</u>

The capability of displaying performance measures (metrics) is provided for two reasons. First, the metric(s) that the QAM optimized on must be reported. Secondly, other metrics, which are not optimized upon, are shown for comparison purposes to be aware of the effects of the runs on alternative metrics.

The four metrics that can be displayed on the reports:

(1) Attrition (ATT). Values range from 0.0 to 1.0 and represent the average probability of applicants attriting from the Army before expiration of their initial enlistment.

(2) Projected Aptitude Area. Scores range from 40 to 155 and represent the applicants average Aptitude Area Composite score (i.e. clerical, technical, etc.) associated with the MOS.

(3) MOS Utility. Scores range from 0 to 100 and represent the utility an assignment in the MOS to the Army.

(4) Skills Qualification Test Scores. Scores range from 0 to 100 and show the predicted scores received on the SQT.

A fifth metric, DEP/ATT savings, is currently being implemented. This new metric is an estimation of how much the Army saves in aborted training costs by placing an recruit in the DEP.

Three of the five metrics may be displayed at a time due to space considerations.

Report Procedures

Two issues drove the design of the report generation procedures. The first was the accomodation of the user's requirements for reports; the second was the computational need to reduce the processing time for the creation of reports. The user wants the ability to create report(s) at any point in time (i.e. during and/or after a simulation). Once selected, however, reports need to be produced as quickly as possible.

The chosen design is to have two report generators operating in batch mode. The first, the during-simulation generator, produces reports while the current simulation is running. The second, the post-simulation generator, produces reports after the simulation has completed and reports are rquested by the user.

The during-simulation generator allows the user to select which reports and options he wants from a menu prior to the beginning of the simulation. Then, when the simulation runs, those reports will be generated at the end of each iteration.

If the user wishes to generate reports after the simulation he can use the post-simulation generator. He selects the options and reports that he wishes to see from an interactive on-line menu. These requests are then written to a command file, which the generator uses for file parameters when it startedin batch mode.

If the user wishes to generate reports pertaining to a previous simulation he must use the post-*simulation* generator. The during-simulation generator will only produce reports pertaining to the current simulation. After the report generators have been run, the results will be automatically spooled to a designated printer.

Support for Report Generators. Two routines were developed that create data files which minimize the processing time of the report generators. The Metrics File routine performs calculations on the metric scores from each record in the user selected applicant-contract file (secondary); the Brick Chart routine computes data for the Brick Charts. Both routines are only executed once for each secondary and ACM output file.

Data files created by the Metrics File routine enable the generators to readily access the heavily used metric data when creating future reports. The second data file, created by the Brick Chart routine, enables future creation of Brick charts without having to read sequentially through each ACM output file. The information in these two files can be seen in Tables B-17, B-18, and B-19.

The information record displayed in Table B-17 is used to determine if any pertinent data, with respect to the reports, has been changed. If, for example, the cluster definitions change, the name of the cluster file will be different. The report generators will check for this change by checking the variable, MOSCLFILE, and if it has changed, the Metrics file will need to be regenerated.

TABLE B-17
RECORD STRUCTURE FOR ACMCONT FILE

Record Name: CONTREC

NAME	TYPE	SIZE	DESCRIPTION
FILENAME	CHAR	7	The name of the file
MONTHMOS	CHAR	6	Cont month & MOS : OCT11X
NUMCONTS(12,2,2,3)	INT	15	Number of contracts by demographics.
First dimension:	Accession month of FY, Jan..Dec order		
Second dimension:	Gender		1 - male, 2 - female
Third dimension:	MCAT		1 - 1-3A, 2 - 3B-V
Fourth dimension:	Edcert		1 - HSSR, 2 - HSDG, 3 - NHSG
DEP(2,2,3)	INT	15	The total number that DEP to the next FY
First dimension:	Gender		1 - male 2 - female
Second dimension:	MCAT		1 - 1-3A 2 -3B-V
Third dimension:	Edcert		1 - SNR 2 - HSG 3-NHG

TABLE B-18
METRICS FILE INFORMATION RECORD STRUCTURE

Record Name: ACTMETINFO

NAME	TYPE	SIZE	DESCRIPTION
FILENAME	CHAR	7	The name of the file
INFOKEY	CHAR	3	Dummy Key always "000"
MOSCLFILE	CHAR	7	MOS to Cluster File
MODIFYFLAG	CHAR	6	Flag indicating whether MOS to Cluster File has been modified
SQTFILE	CHAR	7	SQT Metric File
ATTFILE	CHAR	7	Attrition Metric File
WRTFILE	CHAR	7	Worth Metric File
FILLER	CHAR	7	Fills out the record

TABLE B-19
METRICS FILE DATA RECORD STRUCTURE

Record Name: ACTMETRECORD

NAME	TYPE	SIZE	DESCRIPTION
FILENAME	CHAR	7	The name of the file
ACCESSMOS	CHAR	3	Military Occupational Skill
CONMETRICS(6,12,6)	INT	7	CON - Contract Date within Recruit Year & Ship date is within the Recruit Year also
CON2METRICS(6,12,6)	INT	7	CON2 - Contract Date within Recruit Year & Ship date is outside of the Recruit Year
ACCMETRICS(6,13,6)	INT	7	ACC - Accession Date

First Dimension AFQT Category where:
- 1 — MCAT 1
- 2 — MCAT 2
- 3 — MCAT 3A
- 4 — MCAT 3B
- 5 — MCAT 4
- 6 — MCAT 5 .. Just in case they exist on the file

Second Dimension Accession (or Contract) Month where:
- 1 — January of Current Recruit Year
- 2 — February of Current Recruit Year

. . .
- 12 — December of Current Recruit Year
- 13 — Next Recruit Year

Third Dimension Metric Total Counts where:
- 1 — Aptitude Area Score
- 2 — Projected SQT Score
- 3 — Attrition Rate
- 4 — AIR Worth Measure
- 5 — Dep/Att Savings
- 6 — Total Number of Actual Accessions

Report Assignments

The QAM determines the long-range assignments through the use of optimization; the ACM determines short-range assignments through the use of heuristic simulations. The QAM assignments are only displayed on the cluster level because only data at that level is available. The user has the option of choosing summary reports, which provide the data over a cumulative number of iterations. A comparison can be seen between the QAM assignments, ACM assignments, and historical assignments (i.e., actual assignments as shown on reports under the "ACT" column) in the cluster reports.

At the MOS level, the data is displayed by AFQT Category and overall for the short-range and historical assignments. These assignments are displayed at the cluster level and MOS level. The two types of assignments are contracts and accessions.

Contracts. Contracts is the term used to describe those applicants that have actually signed a contract to join the Army. Reports have been developed to display metrics on assignments which both contracted and accessed in the fiscal year. A second report displays assignments made in the fiscal year which were accessed beyond the fiscal year. Another metric report has been developed that shows total contracts, i.e., a cumulative report on those who sign a contract during the fiscal year without regard to when they access.

Several reports display information on *contracts*. They include five metric reports, two brick charts, and a quality goal report. An example of a contract metric report is provided in Figure B-5.

Optimization Metrics. This report is generated for an optimization only simulation encompassing one year of data. In addition to the assignments, this report also displays metrics. The actual metrics are calculated from the fiscal year applicant-contract (primary) file as opposed to the other metric reports, which use the user selected applicant-contract (secondary) file. The primary file is used because during this type of simulation the secondary file is not utilized. The DEP values that appear on this report represents the historical DEP pool. An example can be seen in Figure B-6.

Accessions. This is the term used for those applicants that have reported for duty. In respect to the reports, the accession data only references those that occur during the fiscal yeat. Several reports are available for this population, including two metric, an average aptitude area, and a quality goal report. An example of a MOS-level Metric Accessions report can be seen in Figure B-7. Note data on all MOS are not provided for simplicity.

METRICS BY CLUSTER: CONTRACTS ACCESSING WITHIN FISCAL YEAR 1984

ITERATION: 1 SIMULATION NAME: R84BASE

	CLUSTER TITLE	INVENTORIES OAM	INVENTORIES ACM	INVENTORIES ACT	PROJECTED AA OAM	PROJECTED AA ACM	PROJECTED AA ACT	ATTRITION OAM	ATTRITION ACM	ATTRITION ACT	MOS WORTH OAM	MOS WORTH ACM	MOS WORTH ACT
(36)	CLUSTER 36	27	0	3	126.9	*****	112.0	0.156	*****	0.241	76.9	*****	32.6
(27)	CLUSTER 27	209	11	20	109.7	111.7	116.9	0.193	0.197	0.241	49.8	67.4	72.5
(50)	CLUSTER 50	8	1	0	109.0	102.0	*****	0.241	0.200	*****	51.5	25.0	*****
(42)	CLUSTER 42	1	0	2	109.0	*****	123.0	0.172	*****	0.178	38.8	*****	73.7
(39)	CLUSTER 39	4	0	1	114.0	*****	116.0	0.183	*****	0.385	40.6	*****	54.0
(1)	CLUSTER 1	9	1	0	127.9	134.0	*****	0.187	0.187	*****	64.5	19.3	*****
(56)	CLUSTER 56	76	2	3	112.2	101.5	113.7	0.196	0.361	0.193	77.6	64.4	67.3
(30)	CLUSTER 30	38	4	3	101.6	88.0	101.3	0.228	0.299	0.216	25.0	47.9	36.8
(52)	CLUSTER 52	104	0	9	98.6	*****	101.8	0.231	*****	0.235	66.7	*****	75.1
(9)	CLUSTER 9	1	1	0	116.0	117.0	*****	0.178	0.178	*****	9.7	4.1	*****
(34)	CLUSTER 34	16	0	0	127.0	*****	*****	0.209	*****	*****	70.2	*****	*****
(43)	CLUSTER 43	0	0	0	*****	*****	*****	*****	*****	*****	*****	*****	*****
(47)	CLUSTER 47	6	0	1	116.2	*****	107.0	0.208	*****	0.397	43.0	*****	6.9
(4)	CLUSTER 4	62	13	3	127.0	127.8	115.3	0.210	0.208	0.300	71.9	23.6	46.3
(17)	CLUSTER 17	43	6	8	109.5	111.5	104.6	0.333	0.236	0.300	37.2	28.9	49.8
(37)	CLUSTER 37	43	0	3	114.0	*****	121.7	0.224	*****	0.241	48.2	*****	63.0
(21)	CLUSTER 21	8	1	0	111.4	95.0	*****	0.229	0.246	*****	33.4	4.1	*****
(25)	CLUSTER 25	77	20	9	107.4	101.0	100.2	0.249	0.262	0.343	27.4	40.1	20.5
(32)	CLUSTER 32	364	7	27	114.1	97.7	109.9	0.297	0.349	0.291	77.3	88.9	71.7
(41)	CLUSTER 41	5	0	0	114.0	*****	*****	0.213	*****	*****	8.6	*****	*****
(2)	CLUSTER 2	2	2	0	114.0	115.5	*****	0.219	0.181	*****	40.6	20.7	*****
(14)	CLUSTER 14	7	4	0	110.4	117.0	*****	0.235	0.240	*****	38.0	12.1	*****
(11)	CLUSTER 11	14	4	0	114.0	116.5	*****	0.234	0.238	*****	27.6	32.2	*****
(12)	CLUSTER 12	17	3	3	115.0	114.3	119.7	0.245	0.239	0.317	30.4	6.0	22.8
(29)	CLUSTER 29	12	0	0	107.8	*****	*****	0.258	*****	*****	15.8	*****	*****
(48)	CLUSTER 48	6	0	0	112.0	*****	*****	0.237	*****	*****	32.9	*****	*****
(55)	CLUSTER 55	6	0	0	127.0	*****	*****	0.252	*****	*****	93.3	*****	*****
(20)	CLUSTER 20	154	24	9	103.5	106.4	113.2	0.449	0.424	0.257	29.8	30.4	65.6
(7)	CLUSTER 7	7	5	0	109.3	110.4	*****	0.266	0.263	*****	32.4	6.9	*****
(26)	CLUSTER 26	400	43	26	103.8	103.4	111.5	0.330	0.342	0.347	44.3	46.7	67.3
(53)	CLUSTER 53	218	4	22	117.7	102.8	108.5	0.279	0.300	0.301	85.3	32.6	84.3
(38)	CLUSTER 38	6	0	0	107.7	*****	*****	0.401	*****	*****	36.4	*****	*****
(3)	CLUSTER 3	0	0	0	*****	*****	*****	*****	*****	*****	*****	*****	*****
(6)	CLUSTER 6	7	0	1	113.6	*****	132.0	0.385	*****	0.300	45.5	*****	82.7

Figure B-5. Metric Report.

METRICS BY CLUSTER: CONTRACTS ACCESSING WITHIN FISCAL YEAR 1984

ITERATION: 1

SIMULATION NAME: R84BASE

	CLUSTER TITLE	INVENTORIES			PROJECTED AA			ATTRITION			MOS WORTH		
		QAM	ACN	ACT	QAM	ACN	ACT	QAM	ACN	ACT	QAM	ACN	ACT
(5)	CLUSTER 5	29	12	4	106.1	103.9	102.0	0.269	0.267	0.421	36.2	23.6	28.9
(18)	CLUSTER 18	109	32	16	109.0	108.6	106.5	0.290	0.368	0.405	55.8	49.5	38.1
(46)	CLUSTER 46	10	0	2	112.8	*****	110.5	0.385	*****	0.292	55.0	*****	36.8
(23)	CLUSTER 23	31	15	3	103.8	114.9	105.0	0.495	0.291	0.391	24.1	72.2	29.8
(40)	CLUSTER 40	1	0	0	108.0	*****	*****	0.385	*****	*****	8.9	*****	*****
(54)	CLUSTER 54	139	2	17	118.4	97.5	108.6	0.272	0.393	0.294	88.6	98.0	77.1
(15)	CLUSTER 15	48	1	1	108.0	115.8	108.0	0.284	0.284	0.483	49.8	26.3	68.1
(44)	CLUSTER 44	0	0	0	*****	*****	*****	*****	*****	*****	*****	*****	*****
(16)	CLUSTER 16	35	10	4	104.7	104.8	117.5	0.300	0.309	0.296	43.0	34.5	64.5
(8)	CLUSTER 8	5	4	0	99.0	98.8	*****	0.385	0.385	*****	6.2	1.2	*****
1(35)	CLUSTER 35	47	0	2	108.0	*****	104.5	0.428	*****	0.301	58.1	*****	48.3
(45)	CLUSTER 45	7	0	1	104.6	*****	107.8	0.321	*****	0.608	59.3	*****	65.2
(24)	CLUSTER 24	365	76	33	116.1	116.8	99.7	0.355	0.290	0.360	41.9	44.5	26.7
(28)	CLUSTER 28	54	0	5	115.7	*****	110.0	0.295	*****	0.317	29.7	*****	17.3
(33)	CLUSTER 33	264	8	14	104.5	90.3	94.3	0.471	0.455	0.434	29.9	41.4	38.2
(51)	CLUSTER 51	748	12	73	99.5	92.8	106.8	0.348	0.350	0.373	50.3	68.9	75.8
(10)	CLUSTER 10	19	5	2	100.0	100.8	119.5	0.408	0.402	0.292	10.5	4.1	33.3
(22)	CLUSTER 22	40	3	2	95.2	92.3	97.8	0.391	0.383	0.366	3.7	3.1	13.3
(49)	CLUSTER 49	3	0	0	124.0	*****	*****	0.324	*****	*****	66.9	*****	*****
(19)	CLUSTER 19	261	25	18	97.7	96.7	110.1	0.410	0.389	0.458	23.3	61.5	53.6
(13)	CLUSTER 13	42	2	6	107.1	122.0	105.0	0.576	0.354	0.422	49.4	53.4	40.2
(31)	CLUSTER 31	28	6	1	104.1	96.3	93.0	0.453	0.445	0.445	56.4	26.7	52.9
	TOTALS	4242	369	357	107.6	107.5	107.6	0.329	0.321	0.339	50.0	43.5	58.9

Figure B-5. Metric Report (continued).

METRIC COMPARISON BY CLUSTER

GLOBAL OPTIMIZATION VS HISTORIC DATA

(#) CLUSTER NAME	ASSIGNMENTS DEP	ASSIGNMENTS OAM	ASSIGNMENTS ACT	APTITUDE AREA DEP	APTITUDE AREA OAM	APTITUDE AREA ACT	PROJECTED SQT DEP	PROJECTED SQT OAM	PROJECTED SQT ACT	ATTRITION DEP	ATTRITION OAM	ATTRITION ACT
(36) COM/INT 1-3B HS	8	600	336	119.8	126.4	118.2	78.44	91.98	85.39	0.298	0.160	0.275
(27) E/M REP 1-4	55	4099	4376	115.6	107.9	113.7	86.80	82.42	87.07	0.205	0.198	0.250
(50) E/M REP 1-4 HS	5	116	107	117.2	109.2	114.9	81.17	84.97	88.03	0.255	0.223	0.215
(42) E/M REP 1-3B HS	1	32	47	121.0	108.5	116.5	82.76	84.73	91.91	0.225	0.211	0.279
(39) MED/DENT SP 1-3B HS	1	87	82	124.0	118.2	112.2	89.95	84.04	74.51	0.284	0.189	0.250
(1) EE REP 1-3A	3	171	172	128.0	123.0	126.5	86.25	95.59	84.07	0.233	0.167	0.251
(56) E/M REP 1-4 MALE	16	1561	1535	113.8	109.3	112.8	75.94	74.43	76.06	0.244	0.215	0.258
(30) CRAFTS 1-4	16	602	644	105.8	108.5	104.4	82.54	84.71	80.32	0.251	0.232	0.267
(52) INF 1-4 MALE	51	2204	2154	103.1	106.8	103.9	88.75	88.90	87.38	0.244	0.234	0.271
(9) OTH TECH SP 1-3B	0	28	46	*****	113.2	121.1	*****	71.89	83.48	*****	0.180	0.248
(34) EE REP 1-3B HS	1	64	83	124.0	114.2	119.9	86.70	74.24	82.86	0.416	0.192	0.278
(43) SERV/SUP 1-3B HS	0	7	19	*****	103.1	114.6	*****	74.77	88.75	*****	0.178	0.283
(47) MED/DENT SP 1-4 HS	2	104	98	107.0	116.5	109.9	86.03	90.66	83.80	0.316	0.274	0.342
(4) EE REP 1-3B	14	1194	1147	121.4	114.8	118.6	84.79	75.40	81.87	0.241	0.210	0.294
(17) EE REP 1-4	33	419	1107	104.8	111.5	111.2	78.17	82.20	79.34	0.267	0.249	0.310
(37) COM/INT 1-3B HS	18	821	723	116.1	112.4	113.1	87.98	79.71	81.81	0.274	0.234	0.290
(21) OTH TECH SP 1-4	1	186	150	116.0	109.7	113.0	72.03	88.38	90.05	0.256	0.249	0.324
(25) FUNC SUP/AD 1-4	28	1362	1388	101.7	114.1	102.4	54.18	71.55	52.56	0.333	0.230	0.353
(32) SERV/SUP 1-4	124	8210	8488	109.6	113.6	105.4	83.91	87.23	80.52	0.271	0.256	0.317
(41) FUNC SUP/AD 1-3B HS	1	95	81	122.0	109.2	115.2	79.63	79.16	87.43	0.276	0.225	0.309
(2) EE REP MALE 1-3A	1	69	79	114.0	113.3	115.6	75.25	84.65	85.51	0.238	0.242	0.272
(14) INF 1-4	0	188	213	*****	109.6	110.9	*****	85.09	83.66	*****	0.272	0.282
(11) FUNC SUP/AD 1-3B	10	194	232	117.5	112.3	114.4	84.51	76.70	78.11	0.273	0.249	0.308
(12) E/M REP 1-3B	6	296	325	117.0	112.6	113.1	82.34	86.25	85.98	0.262	0.262	0.331
(29) CRAFTS 1-4	7	127	136	113.6	106.4	111.4	84.02	76.86	80.18	0.271	0.285	0.332
(48) FUNC SUP/AD 1-4 HS	1	148	185	112.0	110.6	107.9	59.29	66.91	58.90	0.329	0.261	0.289
(55) E/M REP 1-4 MALE	0	162	120	*****	101.8	106.9	*****	57.31	72.31	*****	0.287	0.319
(20) MED/DENT SP 1-4	53	3306	3505	109.4	103.8	107.3	89.88	78.51	78.72	0.303	0.386	0.332
(7) MED/DENT SP 1-3B	3	153	173	114.0	106.8	109.7	81.78	83.22	82.36	0.280	0.274	0.338
(26) E/M REP 1-4	86	8224	8385	108.8	108.7	106.1	78.96	79.86	77.21	0.320	0.282	0.347
(53) INF 1-4 MALE	64	4718	4743	105.1	111.6	108.3	81.42	85.56	81.44	0.315	0.284	0.318
(38) MED/DENT SP 1-3B HS	1	182	149	111.0	99.9	109.6	74.07	72.17	76.77	0.308	0.392	0.322
(3) COM/INT SP 1-4	4	142	92	107.3	103.1	101.0	89.98	88.96	82.78	0.307	0.446	0.347
(6) COM/INT SP 1-3B	7	101	148	114.6	108.4	112.5	87.74	84.71	83.99	0.292	0.385	0.318
(5) EE REP 1-3B	4	628	632	115.3	105.1	112.0	81.58	80.76	85.69	0.331	0.275	0.343

Figure B-6. Optimization Report.

METRIC COMPARISON BY CLUSTER

GLOBAL OPTIMIZATION VS HISTORIC DATA

(#) CLUSTER NAME	ASSIGNMENTS DEP	ASSIGNMENTS GAM	ASSIGNMENTS ACT	APTITUDE AREA DEP	APTITUDE AREA GAM	APTITUDE AREA ACT	PROJECTED SQT DEP	PROJECTED SQT GAM	PROJECTED SQT ACT	ATTRITION DEP	ATTRITION GAM	ATTRITION ACT
(18) COM/INT SP 1-4	33	2124	2433	107.4	105.1	109.0	73.25	73.84	76.30	0.340	0.295	0.374
(46) MED/DENT SP 1-4 HS	7	167	338	111.9	105.1	107.8	89.83	71.67	70.77	0.312	0.309	0.326
(23) OTH TECH SP 1-4	14	584	599	111.1	106.5	109.4	91.50	61.83	76.73	0.303	0.358	0.343
(40) OTH TECH SP 1-38 HS	1	17	19	104.0	104.5	107.1	76.59	84.29	80.01	0.338	0.307	0.335
(54) COM/INT 1-4 MALE	60	2699	3033	107.9	108.4	107.7	84.36	83.67	79.55	0.300	0.306	0.335
(15) INF 1-4	2	1122	1152	107.0	105.2	110.1	72.10	74.85	80.49	0.433	0.297	0.355
(44) EE REP 1-4 HS	0	11	11	*****	103.1	113.0	*****	79.86	88.43	*****	0.289	0.320
(16) EE REP 1-4	9	696	649	111.0	102.9	107.2	85.61	73.84	76.53	0.335	0.309	0.355
(8) OTH TECH SP 1 38	4	79	82	113.8	101.6	108.2	78.74	74.94	78.97	0.325	0.307	0.338
(35) COM/INT SP 1-38 HS	5	1098	777	121.8	101.1	119.0	93.83	64.15	88.72	0.310	0.404	0.328
(45) COM/INT 1-4 HS	1	148	135	90.0	110.9	104.4	85.43	79.33	71.45	0.321	0.372	0.395
(24) FUNC SUP/AD 1-4	154	7368	6941	98.7	103.0	102.2	51.36	60.99	58.65	0.368	0.410	0.370
(20) CRAFTS 1-4	18	971	1041	100.4	99.7	102.6	78.04	71.68	72.10	0.331	0.417	0.344
(33) SERV/SUP 1-4	47	5667	5647	99.8	106.8	100.8	70.54	75.24	65.77	0.398	0.453	0.387
(51) INF 1 4 MALE	259	16930	17252	104.1	109.2	106.2	81.50	79.36	76.63	0.354	0.333	0.366
(10) FUNC SUP/AD 1-38	7	387	260	101.6	99.6	105.7	79.83	63.27	67.73	0.363	0.396	0.373
(22) OTH TECH SP 1-4	7	918	716	108.6	101.2	107.3	87.27	67.73	72.01	0.363	0.386	0.363
(49) E/M REP 1-4 HS	3	69	79	116.7	108.9	111.6	82.53	89.52	88.58	0.353	0.496	0.411
(19) COM/INT SP 1-4	57	2662	6155	101.2	109.9	106.2	69.44	75.89	69.10	0.399	0.341	0.406
(13) INF 1-4	7	770	773	110.7	116.3	112.6	76.23	85.35	79.09	0.430	0.366	0.409
(31) SERV/SUP 1-4	5	571	537	103.0	103.1	102.1	68.55	77.46	69.45	0.510	0.412	0.464
AVERAGE	1325	85656	90534	106.3	108.5	106.9	77.49	78.17	75.69	0.321	0.316	0.344

Figure B-6. Optimization Report (continued)

SUMMARY OF ACCESSIONS IN THE FISCAL YEAR 1984
ITERATION # 1 & SIMULATION NAME: R84BASE

MOS	INVENTORIES			PROJECTED ATTRITION RATE:0-1.0			PROJECTED MOS WORTH:0-100			PROJECTED AA RANGE:40-155		
***	DEP	ACM	ACTUAL	DEP	ACM	ACS1	DEP	ACM	ACTUAL	DEP	ACM	ACTUAL
00J	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
03C	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05D	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05H	1	0	0	0.25	0.00	0.00	70.40	0.00	0.00	118.00	0.00	0.00
05K	1	1	0	0.35	0.25	0.00	61.90	13.60	0.00	112.00	123.00	0.00
11X	59	9	9	0.35	0.36	0.38	78.90	100.00	87.22	107.00	91.00	110.00
12B	18	1	1	0.24	0.20	0.23	79.20	100.00	100.00	107.00	99.00	118.00
12C	2	1	0	0.30	0.47	0.00	74.50	100.00	0.00	105.00	110.00	0.00
12E	1	1	0	0.30	0.24	0.00	68.90	51.40	0.00	106.00	130.00	0.00
12F	2	1	0	0.32	0.27	0.00	64.10	51.40	0.00	99.00	124.00	0.00
13B	18	3	2	0.34	0.34	0.42	42.10	80.50	61.70	98.00	91.00	105.00
13C	0	1	0	0.00	0.28	0.00	0.00	36.00	0.00	0.00	108.00	0.00
13E	2	0	0	0.32	0.00	0.00	77.10	0.00	0.00	112.00	0.00	0.00
13F	4	0	1	0.24	0.00	0.23	64.80	0.00	63.40	111.00	0.00	111.00
13M	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
13R	1	1	0	0.31	0.27	0.00	53.00	36.00	0.00	104.00	109.00	0.00
15D	2	0	0	0.37	0.00	0.00	49.30	0.00	0.00	108.00	0.00	0.00
15E	1	0	0	0.44	0.00	0.00	51.10	0.00	0.00	110.00	0.00	0.00
15J	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16H	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16J	0	1	0	0.00	0.28	0.00	0.00	36.00	0.00	0.00	11 I	
93H	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
93J	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
93P	1	1	0	0.34	0.00	0.00	20.40	0.00	0.00	102.00	97.00	0.00
94B	9	1	0	0.41	0.52	0.00	44.20	80.50	0.00	100.00	97.00	0.00
94F	0	1	0	0.00	0.48	0.00	0.00	6.90	0.00	0.00	130.00	0.00
95B	25	3	3	0.25	0.33	0.37	81.60	100.00	69.70	113.00	112.00	106.67
95C	1	1	0	0.36	0.40	0.00	14.30	6.90	0.00	97.00	85.00	0.00
96B	1	0	0	0.27	0.00	0.00	57.10	0.00	0.00	118.00	0.00	0.00
96D	0	1	0	0.00	0.38	0.00	0.00	23.60	0.00	0.00	109.00	0.00
96H	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
96R	0	1	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	127.00	0.00
97E	1	1	0	0.30	0.00	0.00	74.80	0.00	0.00	123.00	106.00	0.00
97G	0	1	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	125.00	0.00
TOTALS	415	70	55	0.32	0.30	0.35	53.04	51.49	52.73	106.18	107.81	107.31

Figure B-7. Accessions Report.

Average Aptitude Area. This report presents a breakdown of total assignments, and average aptitude area score by demographic grouping and aptitude area (i.e. CL, CO ... ST) for the ACM, secondary applicant file (ACTUAL), and primary applicant file (PRIMARY). Figure B-8 is an example of this report. Note that data has not been provided for each aptitude area for simplicity.

Quality Mission. This report displays the degree of which the quality missions were met for the ACM and historical assignments by gender. It is available for both the cluster and MOS level of assignments.

Contracts and Accessions. There are two reports that display both the number of contracts and accessions. They are in the form of a brick chart.

A brick chart reports display the number of accessions, contracts, and entry DEP by each month in the fiscal year as well as cumulative totals. Brick Charts are used by USAREC to manage contract and accession flow by mission block and by MOS. The QAM and ACM versions are at the cluster and MOS level, respectively. The user has the capability of displaying the data by demographic grouping over ten user selected MOS or clusters, or over all MOS or clusters. An example of a QAM brick chart report follows in Figure B-9.

Graphics

We demonstrated the ability to display graphics in the form of line drawings and histograms in the Version 2 of EPAS on the DLF (the WICAT minicomputer). Graphics is not supported on the NIH computer facility, however, so this reporting capablity was eliminated from Version 3. Future implementation of the graphic capability is anticipated when the EPAS is transferred to an Army computer, assuming that the selected site supports graphics.

AIRRUN4 AVERAGE APTITUDE AREA SCORE FOR CL ITERATION #1

DEMOGRAPHIC GROUP	INVENTORIES ACM	INVENTORIES ACTUAL	INVENTORIES PRIMARY	AVERAGE AA SCORE ACM	AVERAGE AA SCORE ACTUAL	AVERAGE AA SCORE PRIMARY
MALE/I-IIIA/SEN	0	0	0	0.00	0.00	0.00
MALE/I-IIIA/HSG	14	4	0	116.36	117.75	0.00
MALE/I-IIIA/NHSG	1	0	0	118.00	0.00	0.00
MALE/IIIB-IV/SEN	0	0	0	0.00	0.00	0.00
MALE/IIIB-IV/HSG	0	3	0	0.00	95.33	0.00
MALE/IIIB-IV/NHSG	0	2	0	0.00	86.00	0.00
FEMALE/I-IIIA/SEN	0	0	0	0.00	0.00	0.00
FEMALE/I-IIIA/HSG	1	12	0	107.00	103.58	0.00
FEMALE/I IIIA/NHSG	0	0	0	0.00	0.00	0.00
FEMALE/IIIB-IV/SEN	0	0	0	0.00	0.00	0.00
FEMALE/IIIB-IV/HSG	1	1	0	92.00	98.00	0.00
FEMALE/IIIB-IV/NHSG	0	0	0	0.00	0.00	0.00
SUB TOTALS	17	22	0	114.47	103.18	0.00

AIRRUN4 AVERAGE APTITUDE AREA SCORE FOR CO ITERATION #1

DEMOGRAPHIC GROUP	INVENTORIES ACM	INVENTORIES ACTUAL	INVENTORIES PRIMARY	AVERAGE AA SCORE ACM	AVERAGE AA SCORE ACTUAL	AVERAGE AA SCORE PRIMARY
MALE/I-IIIA/SEN	0	0	0	0.00	0.00	0.00
MALE/I-IIIA/HSG	1	7	0	109.00	118.86	0.00
MALE/I-IIIA/NHSG	3	0	0	108.00	0.00	0.00
MALE/IIIB-IV/SEN	0	0	0	0.00	0.00	0.00
MALE/IIIB-IV/HSG	6	6	0	92.83	101.50	0.00
MALE/IIIB-IV/NHSG	0	0	0	0.00	0.00	0.00
FEMALE/I-IIIA/SEN	0	0	0	0.00	0.00	0.00
FEMALE/I-IIIA/HSG	0	0	0	0.00	0.00	0.00
FEMALE/I-IIIA/NHSG	0	0	0	0.00	0.00	0.00
FEMALE/IIIB-IV/SEN	0	0	0	0.00	0.00	0.00
FEMALE/IIIB-IV/HSG	0	0	0	0.00	0.00	0.00
FEMALE/IIIB-IV/NHSG	0	0	0	0.00	0.00	0.00
SUB TOTALS	10	13	0	99.00	110.85	0.00

Figure B-8. Average Aptitude Area Report.

FY 84 BRICKS ACROSS ALL CLUSTERS AND ALL DEMOGRAPHICS

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	FY85	TOTAL	CUMULATIVE TOTALS	TOTAL ACCESS
OCT ACCESSIONS	10024													10024	10024	
ENTRY DEP	10799	8629	3993	4088	1210	313	82	310	3569	3513	1046	168	0	37720		37720
CONTRACTS	-775	158	77	3416	1811	591	206	51	229	733	1129	833	1	8460	8460	
NOV ACCESSIONS		8394												8394	18418	
ENTRY DEP		8787	4070	7504	3021	904	288	361	3798	4244	2175	1001	1	36156		46180
CONTRACTS		-393	609	1639	1553	947	196	87	191	553	1363	974	0	7719	16179	
DEC ACCESSIONS			4356											4356	22774	
ENTRY DEP			4679	9143	4574	1851	484	448	3989	4799	3538	1975	1	35481		53899
CONTRACTS			-323	1070	1672	1655	344	90	238	403	1335	1053	4	7741	23920	
JAN ACCESSIONS				10202										10202	32976	
ENTRY DEP				10213	6246	3506	828	538	4227	5402	4873	3028	5	38866		61640
CONTRACTS				-11	3982	1243	269	184	536	917	1245	1480	15	9860	33780	
FEB ACCESSIONS					9869									9869	42845	
ENTRY DEP					10228	4749	1097	722	4763	6319	6118	4508	20	38524		71500
CONTRACTS					-359	4149	617	262	264	887	597	1451	143	8011	41791	
MAR ACCESSIONS						8798								8798	51643	
ENTRY DEP						8898	1714	984	5027	7206	6715	5959	163	36666		79511
CONTRACTS						-100	3378	636	313	872	614	1248	266	7227	49018	
APR ACCESSIONS							5967							5967	57610	
ENTRY DEP							5092	1620	5340	8078	7329	7207	429	35095		86738
CONTRACTS							875	3346	349	1032	638	1490	304	8054	57072	
MAY ACCESSIONS								5955						5955	63565	
ENTRY DEP								4966	5709	9110	7967	8697	733	37182		94792
CONTRACTS								989	997	1696	1486	846	811	6825	63897	
JUN ACCESSIONS									5788					5788	69353	
ENTRY DEP									6706	10806	9453	9543	1544	38052		101617
CONTRACTS									-918	366	1391	1255	4890	6984	70881	
JUL ACCESSIONS										11172				11172	80525	
ENTRY DEP										11172	10844	10798	6434	39248		108601
CONTRACTS										0	135	898	8295	9328	80209	
AUG ACCESSIONS											10979			10979	91504	
ENTRY DEP											10979	11696	14729	37404		117929
CONTRACTS											0	0	8481	8481	88690	
SEP ACCESSIONS												11696		11696	103200	
ENTRY DEP												11696	23210	34906		126410
CONTRACTS												0	8062	8062	96752	
EXIT DEP TO NEXT FY													31272			

Figure B-9. Brick Chart by Cluster.

ESTABLISH SYSTEM FRAMEWORK

The support computer for the current EPAS is the National Institute Health Computer Facility. This facility utilized IBM 3090 mainframes operating under the VMS/XA computer system. Data access is through IBM's VSAM facility. Excepting the ARCNET network algorithm, all programs have been developed in the PL1 programming language.

The Process Test System (PTS) provides the overall system control and user interface procedures necessary to run EPAS. Dial-up access NIH is provided through the Demonstration Laboratory Facility (DLF) WICAT 160 computer. A specially-developed Pascal program, BYPASS, is used to translate control sequences between the IBM mainframe and the user terminals.

An interactive, user-friendly front-end provides the necessary interface between user and system. It provides developers and users with an easy system interface and expedites debugging and fine tuning. The front-end provides the following capabilities:

(1) Fully Menu Driven. Access to all components of EPAS is achieved through menu panels. The user controls choices via cursor controls, space bar or the depressing of the first letter(s) of the menu item desired. A tree structure allows the user to easily identify the path into the specific action to be performed.

(2) Use of Video Attributes. Full use of video attributes, including reverse video and blinking, facilitates rapid identification of selected options. The indicated item is selected with the RETURN key.

(3) Standardized Control Keys. While each menu panel displays information unique to the process to be performed, the control functions available to the user remain consistent at all levels within the system. Control functions are initiated by holding the keyboard's "CONTROL" key down (indicated by the ^ symbol) and simultaneously depressing the indicated alphabetic key. Keys which are enabled are:

(a) ^A -- Abort. This key allows the user to retreat one panel. Any information which was entered prior to using the ^A function is lost.

(b) ^F -- File. This key indicates the completion of a panel. All user-entered data is accepted and passed onto appropriate functions, files, or programs within EPAS and processing continues with the next menu.

(c) ^T -- Tutorial. This key initiates an on-line tutorial capability. Instructions are displayed on the user's terminal identifying what actions are necessary to complete the current menu.

(d) ^X -- eXit. This key exits EPAS completely.

(4) Data Editing. Data is automatically edited by the system as it is entered. This provides the user with immediate feedback and verification of ongoing transactions.

(5) Error Messages. Error messages and warnings are displayed at the bottom of the screen when the erroneous data or parameters are entered (not after all items in the panel are entered).

(6) Standardized Editors. A standard editor to add, modify, copy or delete categories of EPAS parameters such as policies, MOS requirements, and the training program.

Provide Execution Control

EPAS provides a blend of interactive (foreground) and batch (background) execution. The interactive portion of the system allows the user to define policy parameters, examine model status, and review reports with immediate feedback and access. Once the desired job parameters have been fully defined, the models are automatically submitted for batch execution, freeing the user's terminal for other activities. The system execution controls design features the following capabilities:

(1) Support for any user-specified combinations of applicant, policy, MOS requirements, school seat and training, etc. input data files.

(2) Support the EPAS iteration methodology.

(3) Support for any number of iterations, starting at any time point; further, the system supports rerunning iterations.

(4) Support for automatic, on-line submittal of batch (off-line) EPAS runs. These submittals include simulations and optimizations, report generation, metrics reference generation and applicant/contractee file generation.

(5) Batch control programs control and monitor batch EPAS run submittals.

The Run File. A file interface, called the Run File supports the first three items on the list, above. Table B-1 shows the information contained within this file. It is the interface for uses to specify all execution-related files and parameters for batch operation. It also is the medium which the batch system uses to report on run status, temporary files to be used and other run-related information. An editor provides the user interface and supports the following functions:

TABLE B-1
RUN FILE RECORD STRUCTURE

NAME	TYPE	SIZE	DESCRIPTION
***** EXECUTION RELATED PARAMETERS *****			
SIMNAME	CHAR	7	Unique name of the EPAS run
DESCRIPTION	CHAR	40	Text description of run
MODULES	INTEGER	2	Type of run: 1 - Optimization 2 - Simulation 3 - Contractee Forecast 4 - Applicant Assignment
OPTIM_ANALYSIS	INTEGER	2	Optimization Analysis: 0 - Regular 1 - Mission Goal 2 - Reserved 3 - Sensitivity
BEGINYR	INTEGER	2	Starting Recruit Year
BEGINMTH	INTEGER	2	Starting Recruit Month
BEGINWK	INTEGER	2	Starting Recruit Week
BEGINWKOFMTH	INTEGER	2	Starting Recruit Week of Month
BEGINDAY	INTEGER	2	Starting Recruit Week Day
BEGIN_FYYR	CHAR	4	Starting FY Year
BEGIN_FYMTH	CHAR	2	Starting FY Month
BEGIN_FYDAYOFMTH	CHAR	2	Starting FY Day of Month
ITERMODE	INTEGER	2	Iteration Mode: 0 - No iterations 1 - Weekly 2 - Monthly 3 - Yearly
ITERNUMBER	INTEGER	2	Number of Iterations
ITERSTART	INTEGER	2	Starting Iteration Number
ABORTFLAG	INTEGER	2	System Abort: 0 - Abort as required 1 - Do Not Abort unless Fatal
DEPLOSSFLAG	INTEGER		DEP Loss Processing: 0 - No processing 1 - Processing
***** FILE PARAMETERS *****			
APPFILE	CHAR	7	Applicant/Contractee Filename
CLUSTERFILE	CHAR	7	Cluster Filename
DEPFILE	CHAR	7	DEP Loss Filename
METRICFILE	CHAR	7	Metrics Filename
MOSFILE	CHAR	7	MOS Requirements Filename
SCHFILE	CHAR	7	School Seat/Plan Filename

TABLE B-1 (continued)
RUN FILE RECORD STRUCTURE

NAME	TYPE	SIZE	DESCRIPTION
POLICYFILE(10)	CHAR	7	Policy Parameter Filenames: (1) - TRM Policy (2) - QFM Policy (3) - QAM Policy (4) - ACM Policy (5) - ELIM Accessions
***** OUTPUT OPTIONS *****			
REPORTS(20)	INTEGER	2	Report Select Flag: 0 - Not selected 1 - Selected
METRICS(10)	INTEGER	2	Metrics Flag: 0 - Not selected 1 - Selected
ACMBRICK(10)	CHAR	3	Demographic Tree Flag: 0 - Not selected 1 - Selected
QAMBRICK(10)	INTEGER	2	Brick Chart Cluster List (1)=99 indicates all
TRACEFLAG(10)	INTEGER	2	Trace flag: (1) - TRM (2) - QFM (3) - QAM (4) - ACM (5) - PTS (6) - Metrics Generator
***** PROCESSING OPTIONS *****			
COMPOSITE	INTEGER	2	Composite Type: 1 - Old Composite/1980 Norm 2 - New Composite/1980 Norm 3 - Old Composite/1944 Norm 4 - New Composite/1944 Norm (2 is default)
SCALEFLAG	INTEGER	2	Demand Scale Flag: 0 - No scaling 1 - Scaling
SCALEFACTOR	INTEGER	2	Scaling Factor: -1 - Down To 0 - Equal 1 - Up From Applicants Population
SCALEPER	REAL	4	Scaling percentage
YRAPPTOTAL	INTEGER	4	Applicant Yearly Population

TABLE B-1 (continued)
RUN FILE RECORD STRUCTURE

NAME	TYPE	SIZE	DESCRIPTION
QFMMATCH	INTEGER	2	Simulation population match with QFM forecast flag: 0 - No match 1 - Match
OPTIMFACTOR	INTEGER	2	Optimization Metric: 1 - Aptitude Area Score 2 - SQT Score 3 - 1st term Attrition 4 - Worth Measure 5 - DEP/Attrition $
OPTIMWEIGHT(3)	REAL	4	Metrics Weighting Factors
***** HISTORICAL DATA *****			
CURRENTITRER	INTEGER	2	Current Iteration Number
LASTITER	INTEGER	2	Last Iteration Completed
CURRYR	INTEGER	2	Current Recruit Year
CURRMTH	INTEGER	2	Current Recruit Month
CURRWKOFMTH	INTEGER	2	Current Recruit Week of Mth
CURRDAY	INTEGER	2	Current Recruit Day
LASTYR	INTEGER	2	Last Iteration Rec Year
LASTMTH	INTEGER	2	Last Iteration Rec Month
LASTWK	INTEGER	2	Last Iteration Rec Week
LASTWKOFMTH	INTEGER	2	Last Iteration Rec Wk of Mth
LASTDAY	INTEGER	2	Last Iteration Rec Day
TMOSFILE	CHAR	7	Simulation used Rqmts File
TSCHFILE	CHAR	7	Simulation used Sch Seat File
ABORTMOD(3)	CHAR	3	Aborting Module
CURR_FYYR	CHAR	4	Current FY
CURR_FYMTH	CHAR	2	Current FY Month
CURR_FYDAYOFMTH	CHAR	2	Current FY Day of Month

(1) Creating a new run file using information based on a standard run template.

(2) Modifying a previously-executed analysis; this includes the deleting of extraneous work files and other clean-up operations to support the new analysis.

(3) Deleting run file information.

(4) Listing all run file names with user selection capability for editing, creating or deleting.

(5) Reviewing run file information (read only operation - no modifications are allowed).

(6) Detailed error analysis to prevent an infeasible run request, such as requesting a third iteration when the first two iterations have not been run.

Run File Categories. Most of the information contained in the Run File record description is self explanatory. This information is divided into five categories:

(1) Execution-related Parameters. These include the run name and description, the type of run (MODULES), the run start date of the analysis in Reception Station Date terminology (year, month, week, week of month in the year) and in fiscal year terminology, the iteration time span (week, month, year), the number of iterations, the starting iteration (would be greater than 1 if restarting from a previous analysis), and the system abort indicator flag.

(2) File and Record Name Parameters. These include files on applicants and contractees, MOS clusters, DEP loss, metrics, MOS requirements, school seats and training plans, and EPAS policy.

(3) Output-related Parameters. These specify the reports generated after each iteration and the level of trace and debugging for each batch component.

(4) Processing Options. These include the ASVAB composite used (default is new composites, 1980 norm), scaling factors for the MOS requirements and training program. An applicant and contractee forecast match flag (if on, a contractee simulation population will be generated for each iteration that matches the projected population), and the optimization metric used with weights which permit linear combinations of up to three metrics. Scaling changes the relationship between the contractee supply and MOS requirements; demand requirements are scaled up or down while holding supply constant.

(5) Historical Data Parameters. These are read only and cannot be changed by the user. They include processing iteration information, run termination code, aborting module (if abnormal termination), last and current processing dates, and temporary file names for MOS requirements and school seat/training program information. These files have to be altered during EPAS processing so copies are maintained for each iteration in order to retain the original information.

Batch Operations Control. The submittal of batch jobs occurs after the on-line system has completed running. A Command List (CLIST) was developed to execute the on-line system and, at on-line system termination, check a return code to determine if any batch runs are scheduled. If so, the CLIST reads an interface file specifying the type of batch job (simulation, optimization, reports, metric generation, contractee file generation) and the Run File name. Based on this information, the CLIST edits a standard batch submittal JCL file by inserting the run file name and job card information. The edited file is then submitted for batch execution.

A batch control program has been developed for each of the batch operations. This program will read the Run File name from the parameter (PARM) statement in the execution JCL. All other information regarding the execution of the system is contained in the Run File.

APPENDIX C
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APPENDIX D
MASTER PLAN

This appendix contains the Master Plan (6th Year) for Enlisted Personnel Allocation System (EPAS). Its purpose is to present the schedule of remaining work efforts and milestones. It will be revised periodically to accurately reflect progress and changes in resource levels, milestones, tasks, and/or concepts.

In the sections which follow, a brief description of each task is presented with a detailed schedule of activities. These schedules have been developed using Harvard Total Project Manager (HTPM) on an IBM PC/AT. Table D-1 identifies the personnel resources used in the development of the detailed schedules. Table D-2 abstracts the list of contract deliverables which are incorporated within the plan. Figure D-1 presents a PERT chart of the remaining contract tasks.

TASK 1: DESIGN THE OVERALL STUDY AND CONDUCT SYSTEMS ANALYSIS OF ARMY PERSONNEL PROCESS AND DECISION MAKING

Task 1 involved the initial planning for the overall project and a systems analysis of Army personnel planning processes and decision making. In addition, Task 1 included the establishment of a project advisory committee and the establishment of a Demonstration Laboratory Facility (DLF).

Task 1 is complete.

TABLE D-1
PERSONNEL RESOURCES

ABBREV	RESOURCE NAME	DESCRIPTION
Project Dir	Project Director	Senior manager responsible for overall guidance of project
Project Mgr	Project Manager	Manager responsible for day-to-day guidance of project
Stat Anal	Statistical Analyst	Statistician
DB Analyst	Data Base Analyst	Computer systems analyst with concentrated expertise in data base design and development
OR Analyst	Operations Research Analyst	Senior analyst with expertise in the design and development of OR systems, particularly large-scale optimization techniques
Prog Anal	Programmer/Analyst	Computer programmer / systems analyst

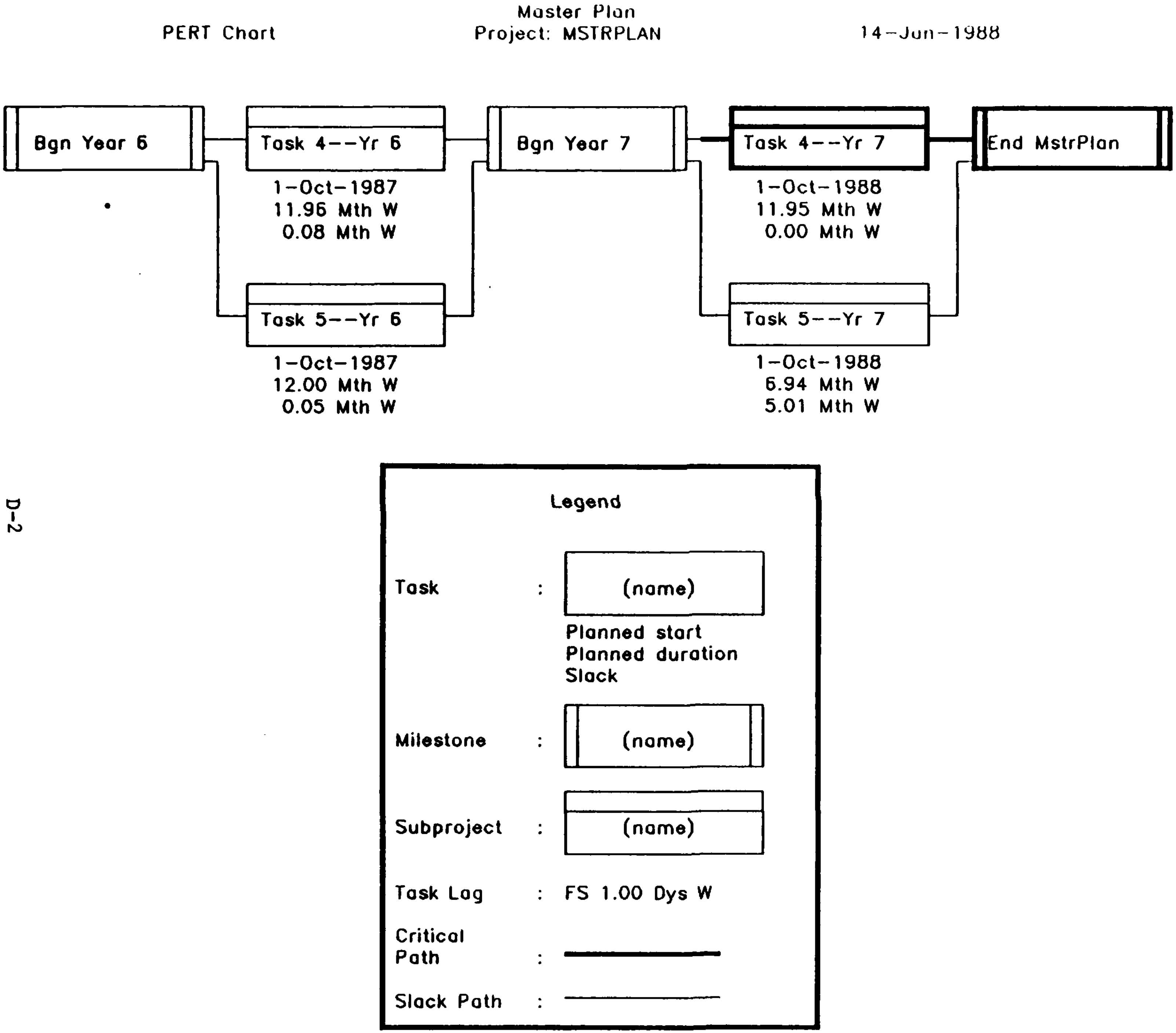

Figure D-1. Pert Chart of Remaining Tasks

TABLE D-2
CONTRACT DELIVERABLES

ITEM No.	DESCRIPTION	
0002AA	Draft Master Plan (1st Year)	
0002AB	Final Master Plan (1st Year)	
0002AC	Biographic List of Proposed Advisory Committee Members	
0002AD	Completed Literature & Data Review	
0002AE	Completed Systems Analysis Plan	
0002AF	Semi-Annual Progress Report	
0002AG	Completed Systems Analysis Report	
0002AH	Draft Master Plan and Annual Report (2nd Year)	
0002AJ	Final Master Plan and Annual Report (2nd Year)	
0002AK	Semi Annual Progress Report	
0002AL	Draft Master Plan and Annual Report (3rd Year)	
0002AM	Final Master Plan and Annual Report (3rd Year)	
0002AN	Completed, Draft Prototype, Computerized Personnel Allocation System	
0002AP	Semi-Annual Progress Report	
0002AQ	Draft Master Plan and Annual Report (4th Year)	
0002AR	Final Master Plan and Annual Report (4th Year)	
0002AS	Completed Cost-Benefit Analysis of Prototype Systems	
0002AT	Semi-Annual Progress Report	
0002AU	Draft Field Test Plan	
0002AV	Complete Prototype, Computerized Enlisted Personnel Allocation System	
0002AW	Draft Master Plan and Annual Report (5th Year)	
0002AX	Final Master Plan and Annual Report (5th Year)	
0002AY	Semi-Annual Progress Report	
0002AZ	Draft Master Plan and Annual Report (6th Year)	
0002BA	Final Master Plan and Annual Report (6th Year)	
0002BB	Semi-Annual Progress Report	3-29-88
0002BC	Draft Final Technical Report	9-29-88
0002BD	Final Technical Report and Associated Products	7-29-89

TABLE D-2 (continued)
CONTRACT DELIVERABLES

ITEM No.	DESCRIPTION	
0002BE	Monthly Progress Report and Formal Briefing on Project Status	EOM+20 days
0002BF	Monthly Computer Data Base Report	EOM+20 days
0002BG	Monthly Technical Support Report	EOM+20 days
0002BH	Project Publications	To be Determined
0002BJ	Milestone Reports	To be Determined

TASK 2: IMPROVE AND/OR DEVELOP NEW OR/MS DECISION-MAKING TECHNIQUES

The purpose of Task 2 was to improve and/or develop new operations research and management science decision-making techniques. Techniques for each of the four EPAS modules were investigated with alternative methodologies developed. In support of this investigation, the DLF was extensively used and enlarged in scope to support additional analyses.

Task 2 is complete.

TASK 3: SELECT APPROPRIATE OR/MS TECHNIQUES FOR THE NPS EPAS AND CONDUCT AN EVALUATION

The purpose of Task 3 is to select appropriate OR/MS techniques and conduct an evaluation in the context of a prototype EPAS. Using the DLF, candidate EPAS constructs were evaluated according to predetermined measures of effectiveness. Based upon these tests and intensive analyses, a prototype EPAS was selected. This prototype EPAS construct is to be subjected to field test at an Army-specified site.

Task 3 is complete.

TASK 4: DEVELOPMENT AND IMPLEMENTATION OF THE OPERATIONAL EPAS

The purpose of Task 4 is to develop a Non-Prior Service (NPS) operational version of EPAS based on the results of the analyses conducted in the previous tasks. During the last contract year, work was concentrated on Task 4 activities.

The initial prototype version of EPAS was developed on the DLF, a WICAT 160 minicomputer, based on the results of analyses conducted under Task 3. The prototype was successfully transferred to the National Institute of Health (NIH) IBM computer. This transference involved the conversion of WICAT Pascal code to PL/1, the development of additional utility programs to support EPAS on the NIH system, revision of methodology by which programs are executed, and major revisions of file structures and access techniques.

EPAS-supported analyses and simulations have been successfully conducted on the NIH system. Execution costs on the NIH system, plus the need to access operational data, have led to the recommendation to transfer the operational EPAS to an Army-owned computer system. The Army's ISC-P computer facility has been identified as the site-of-choice for this transfer. The transfer will require a complete revision of the file structure and access techniques, revisions of the PL/1 code, and modification to the user interfaces.

A User's Manual and other necessary training materials will be developed as part of the transference to the Army-owned computer. It is anticipated that a period of operational support will be provided after the prototype EPAS is fielded to aid users and provide related analytical support.

A benefit/cost analysis (Task 4.2) has been conducted and documented. This report, which documented the importance of EPAS to force readiness and related benefits, was reviewed by the Army in May, 1986.

An Enlisted Retrainee (REPAS) version of EPAS (Task 4.3) was investigated. To avoid redundant effort with similar activities being performed in other Army contracts, this task is currently inactive.

An *analysis of code* of the current allocation system, the REQUEST MOS Match Module (MMM), was conducted (Task 4.4) to determine an interface point between REQUEST and EPAS. This analysis indicated significant differences in the ways the two systems determine MOS to be presented to applicants. Further analysis involving Army personnel, GRC, and the developers of REQUEST will be necessary to finalize the interface requirements and develop detailed design specifications.

Figure D-2 presents the PERT chart for Task 4 activities for the remainder of the contract; Figure D-3 contains the Gantt charts corresponding to the task schedule. Task 4 staffing requirements and task descriptions are provided in Tables D-3 and D-4, respectively.

TASK 5: FIELD TEST AND EVALUATION

The purpose of Task 5 is to evaluate the reliability and validity of the prototype system. The Field Test is to exercise the prototype under actual, operational conditions in accordance with the Field Test Plan.

Figure D-4 presents the PERT chart for Task 5 activities for the remainder of the contract; Figure D-5 contains the Gantt charts corresponding to the task schedule. Task 5 staffing requirements and task descriptions are provided in Tables D-5 and D-6, respectively.

The activities necessary to conduct the Field Test are independent of the site at which they are to be conducted. However, because of the need to test under operational conditions and the cost associated with performing the necessary simulations on the NIH computer, it is anticipated that the Field Test activities will be performed on the Army-owned computer. To the maximum degree feasible, data will be obtained directly from files already residents on Army computers.

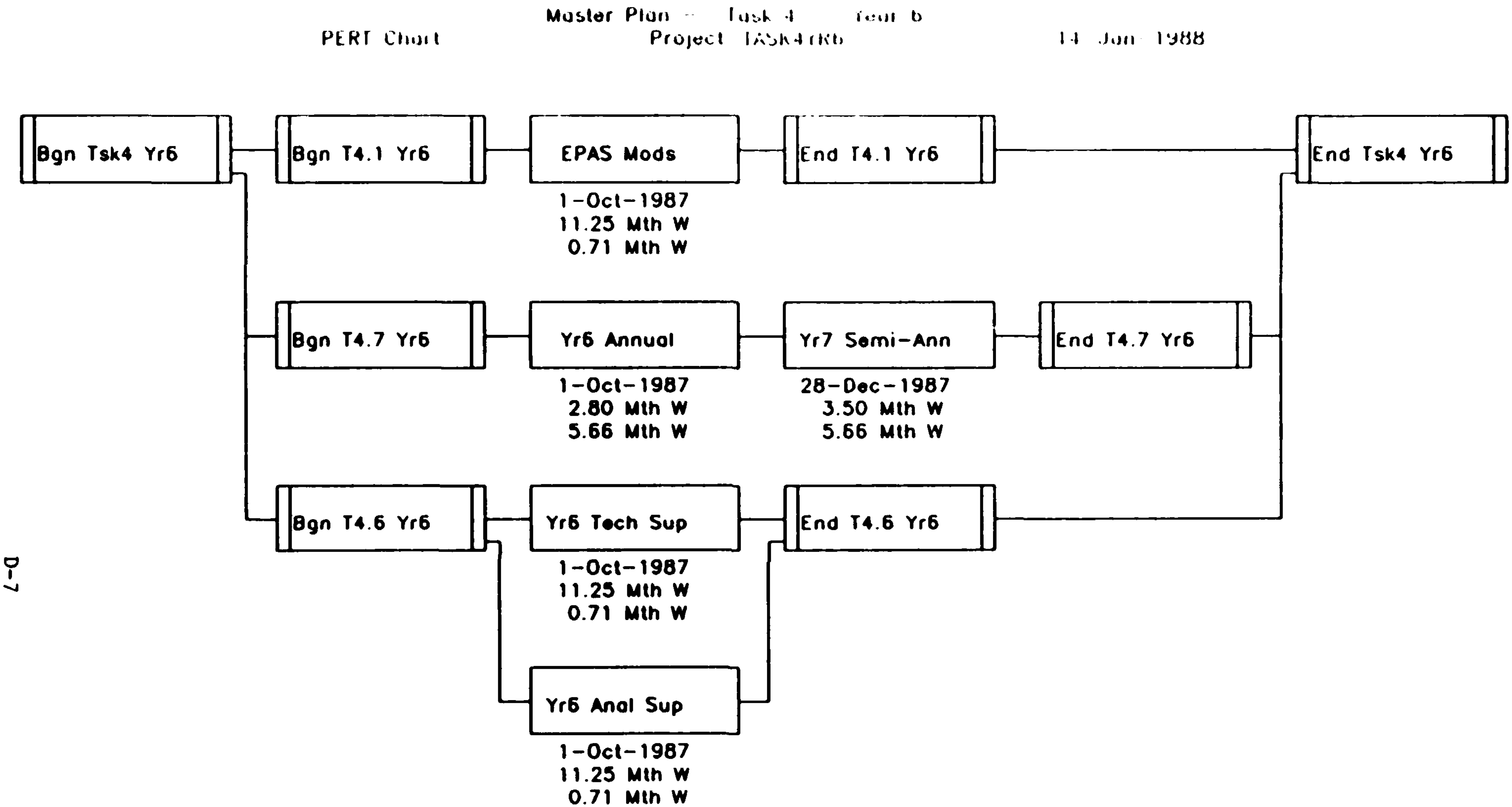

Figure D-2. Pert Chart for Task 4

Master Plan -- Task 4 -- Year 7

PERT Chart   Project: TASK4YR7   14 Jun 1988

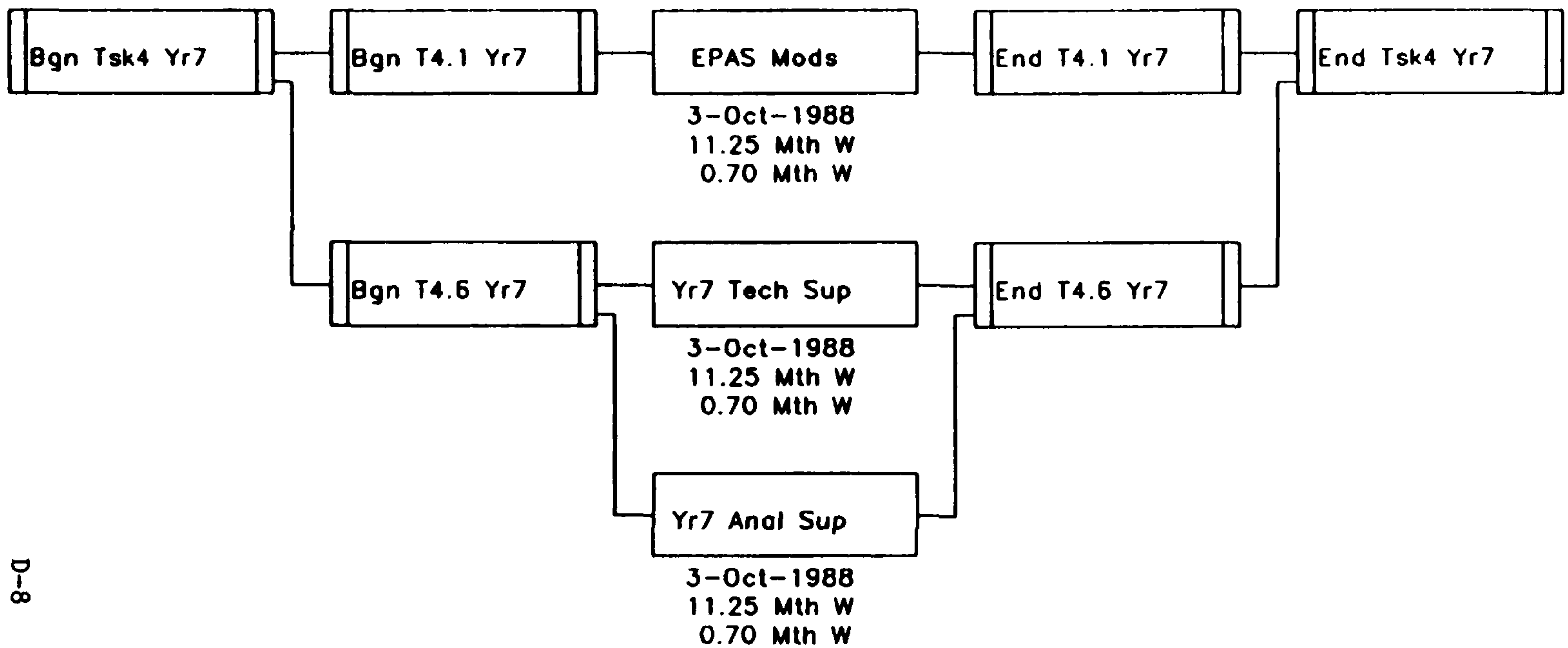

Figure D-2 (Cont'd). Pert Chart for Task 4

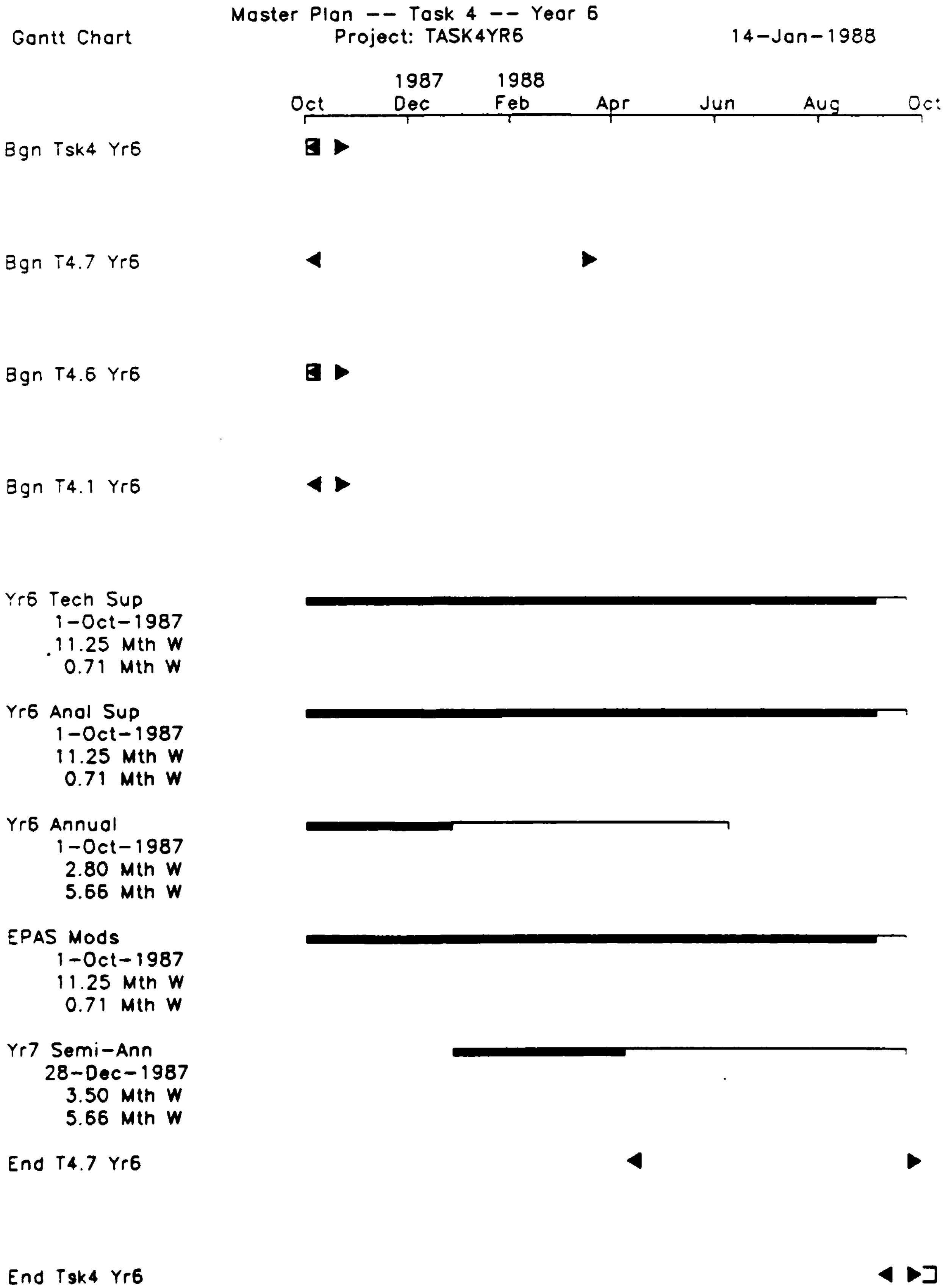

Figure D-3. Task 4 Gantt Chart

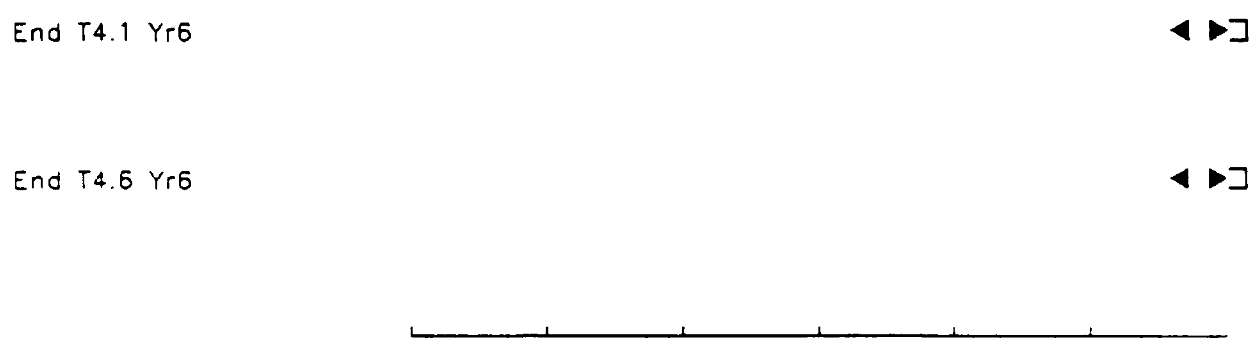

Figure D-3 (Cont'd). Task 4 Gantt Chart

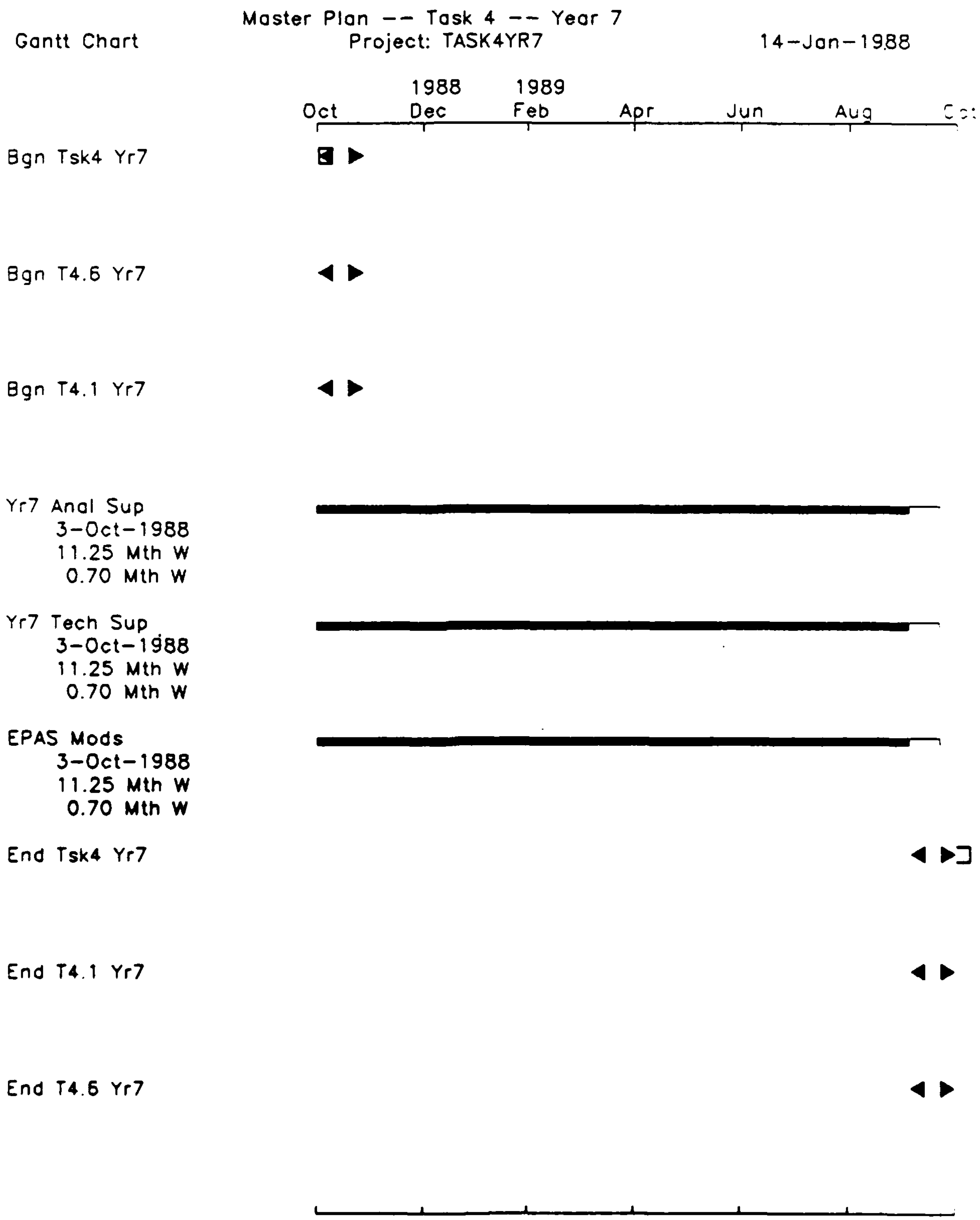

Figure D-3 (Cont'd). Task 4 Gantt Chart

TABLE D-3

TASK 4 TASKING

Master Plan -- Task 4 -- Year 6

Allocations by Task 19-Jan-1988 Page 1

Task name	Task start date	Resource name	Resource quantity
EPAS Mods	1-Oct-1987	OR Analyst	0.050
EPAS Mods	1-Oct-1987	Prog Analyst	0.050
EPAS Mods	1-Oct-1987	Project Mgr	0.050
EPAS Mods	1-Oct-1987	Stat Analyst	0.050
Yr6 Anal Sup	1-Oct-1987	OR Analyst	0.050
Yr6 Anal Sup	1-Oct-1987	Prog Analyst	0.050
Yr6 Anal Sup	1-Oct-1987	Project Dir	0.050
Yr6 Anal Sup	1-Oct-1987	Project Mgr	0.050
Yr6 Anal Sup	1-Oct-1987	Stat Analyst	0.050
Yr6 Annual	1-Oct-1987	Project Mgr	0.400
Yr6 Annual	1-Oct-1987	Stat Analyst	0.400
Yr6 Tech Sup	1-Oct-1987	OR Analyst	0.050
Yr6 Tech Sup	1-Oct-1987	Prog Analyst	0.050
Yr6 Tech Sup	1-Oct-1987	Project Dir	0.050
Yr6 Tech Sup	1-Oct-1987	Project Mgr	0.050
Yr6 Tech Sup	1-Oct-1987	Stat Analyst	0.050
Yr7 Semi-Ann	28-Dec-1987	OR Analyst	0.100
Yr7 Semi-Ann	28-Dec-1987	Project Mgr	0.100
Yr7 Semi-Ann	28-Dec-1987	Stat Analyst	0.100

TABLE D-3 (CONT'D)

TASK 4 TASKING

Master Plan -- Task 4 -- Year 7

Allocations by Task 19-Jan-1988 Page 1

Task name •	Task start date	Resource name	Resource quantity
EPAS Mods	3-Oct-1988	OR Analyst	0.400
EPAS Mods	3-Oct-1988	Prog Analyst	0.800
EPAS Mods	3-Oct-1988	Project Mgr	0.400
EPAS Mods	3-Oct-1988	Stat Analyst	0.400
Yr7 Anal Sup	3-Oct-1988	OR Analyst	0.100
Yr7 Anal Sup	3-Oct-1988	Prog Analyst	0.200
Yr7 Anal Sup	3-Oct-1988	Project Dir	0.100
Yr7 Anal Sup	3-Oct-1988	Project Mgr	0.100
Yr7 Anal Sup	3-Oct-1988	Stat Analyst	0.100
Yr7 Tech Sup	3-Oct-1988	OR Analyst	0.100
Yr7 Tech Sup	3-Oct-1988	Prog Analyst	0.200
Yr7 Tech Sup	3-Oct-1988	Project Mgr	0.100
Yr7 Tech Sup	3-Oct-1988	Stat Analyst	0.100

TABLE D-4

TASK 4 - TASK DESCRIPTIONS

Master Plan -- Task 4 -- Year 6

Task & Milestone List 19-Jan-1988

Task name	Start date	Planned duration	Planned finish	Description	Slack
Bgn T4.1 Yr6	1-Oct-1987		1-Oct-1987		0.76 Mth W
Bgn T4.6 Yr6	1-Oct-1987		1-Oct-1987	Start of EPAS-Suported Activities	0.76 Mth W
Bgn T4.7 Yr6	1-Oct-1987		1-Oct-1987		5.71 Mth W
Bgn Tsk4 Yr6	1-Oct-1987		1-Oct-1987	TASK 4: Develop Prototypt EPAS -- Year 6 Plan	0.76 Mth W
End T4.1 Yr6	8-Sep-1988		8-Sep-1988		0.76 Mth W
End T4.6 Yr6	8-Sep-1988		8-Sep-1988		0.76 Mth W
End T4.7 Yr6	11-Apr-1988		11-Apr-1988		5.71 Mth W
End Tsk4 Yr6	8-Sep-1988		8-Sep-1988		0.76 Mth W
EPAS Mods	1-Oct-1987	11.25 Mth W	8-Sep-1988	Modify and Enhance EPAS as Required	0.76 Mth W
Yr6 Anal Sup	1-Oct-1987	11.25 Mth W	8-Sep-1988	Perform Analytical Support	0.76 Mth W
Yr6 Annual	1-Oct-1987	2.80 Mth W	28-Dec-1987	Report 0002BA: Final Master Plan and Annual Report (Year 6)	5.71 Mth W
Yr6 Tech Sup	1-Oct-1987	11.25 Mth W	8-Sep-1988	FY88 Technical Support	0.76 Mth W
Yr7 Semi-Ann	28-Dec-1987	3.50 Mth W	11-Apr-1988	Item 0002BB: Semi-Annual Progress Report (Year 7)	5.71 Mth W

TABLE D-4 (CONT'D)

TASK 4 - TASK DESCRIPTIONS

Master Plan -- Task 4 -- Year 7

Task & Milestone List 19-Jan-1988 Page 1

Task name	Start date	Planned duration	Planned finish	Description	Slack
Bgn Tsk4 Yr7	1-Oct-1988		1-Oct-1988	FY89--NPS EPAS	0.70 Mth W
BTsk 4.1 Yr7	1-Oct-1988		1-Oct-1988		0.70 Mth W
BTsk 4.6 Yr7	1-Oct-1988		1-Oct-1988		0.70 Mth W
End T4.1 Yr7	8-Sep-1989		8-Sep-1989		0.70 Mth W
End T4.6 Yr7	8-Sep-1989		8-Sep-1989		0.70 Mth W
End Tsk4 Yr7	8-Sep-1989		8-Sep-1989		0.70 Mth W
EPAS Mods	3-Oct-1988	11.25 Mth W	8-Sep-1989	Modifications & Enhancements to NPS EPAS	0.70 Mth W
Yr7 Anal Sup	3-Oct-1988	11.25 Mth W	8-Sep-1989	FY89 Analytical Support Activities	0.70 Mth W
Yr7 Tech Sup	3-Oct-1988	11.25 Mth W	8-Sep-1989	FY89 Technical Support Activities	0.70 Mth W

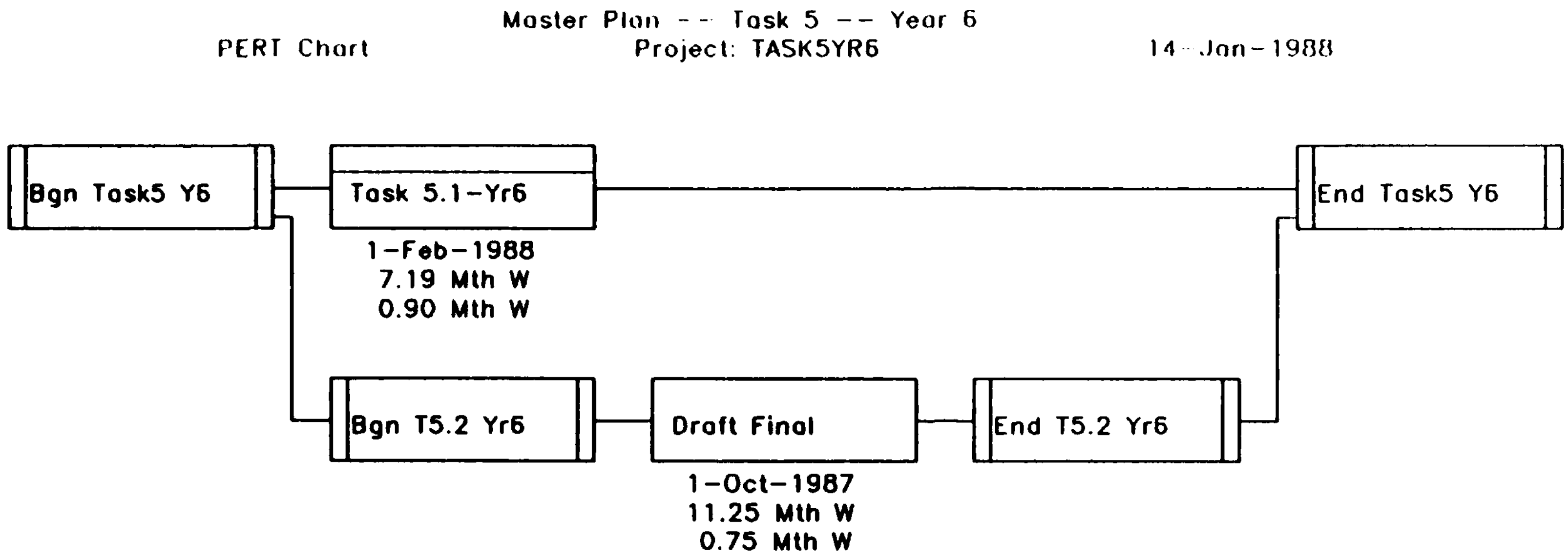

Figure D-4. Task 5 Pert Chart

Master Plan -- Task 5.1 -- Year 6

PERT Chart Project: TASK516 14-Jan-1988

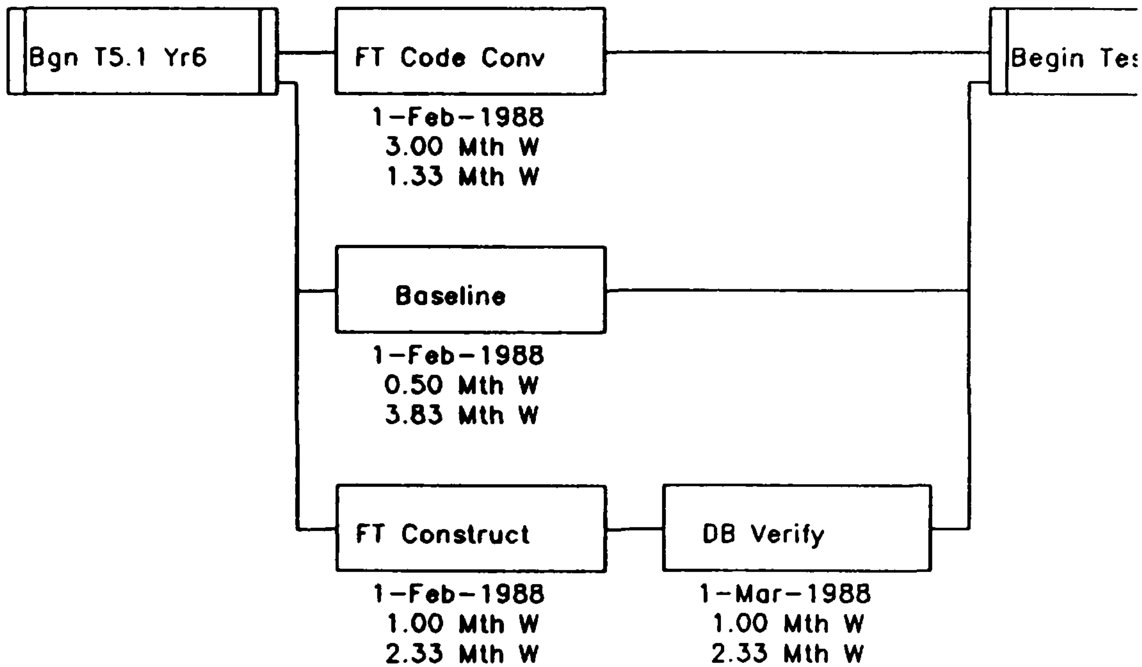

Figure D-4 (Cont'd). •Task 5 Pert Chart

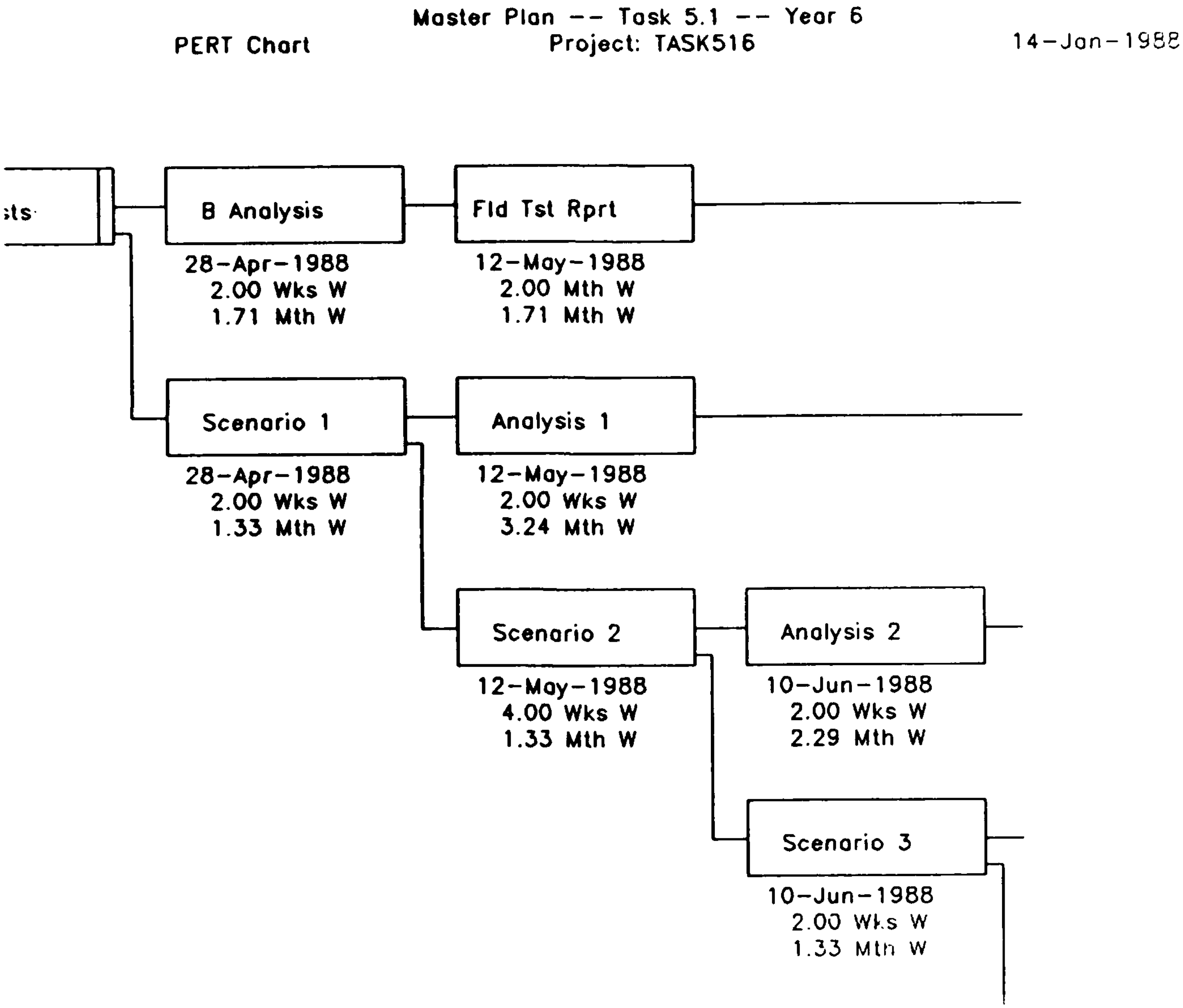

Figure D-4 (Cont'd). Task 5 Pert Chart

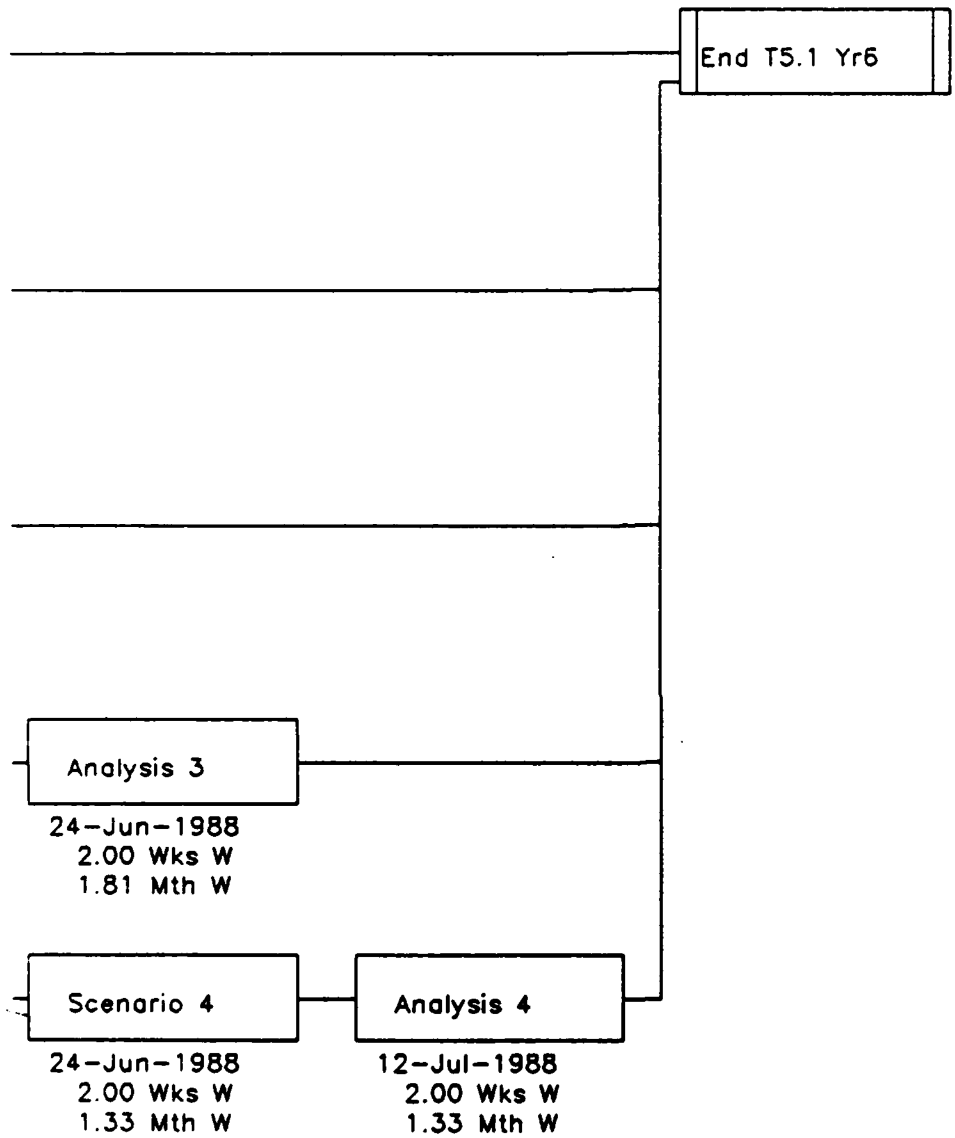

Figure D-4 (Cont'd). Task 5 Pert Chart

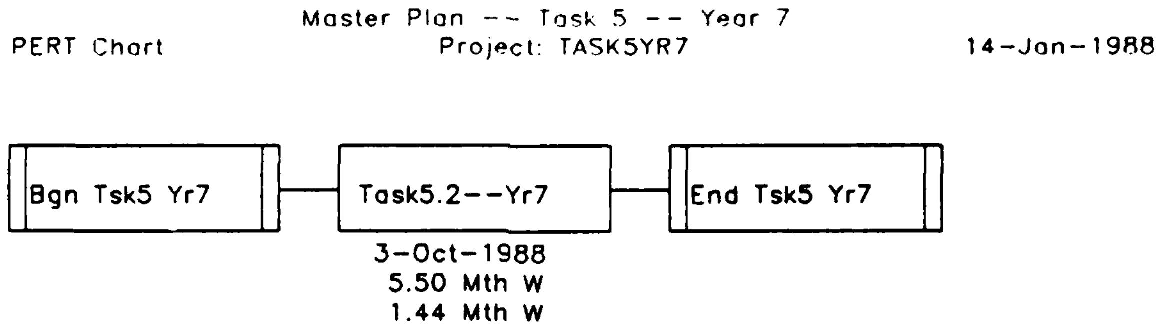

Figure D-4 (Cont'd). Task 5 Pert Chart

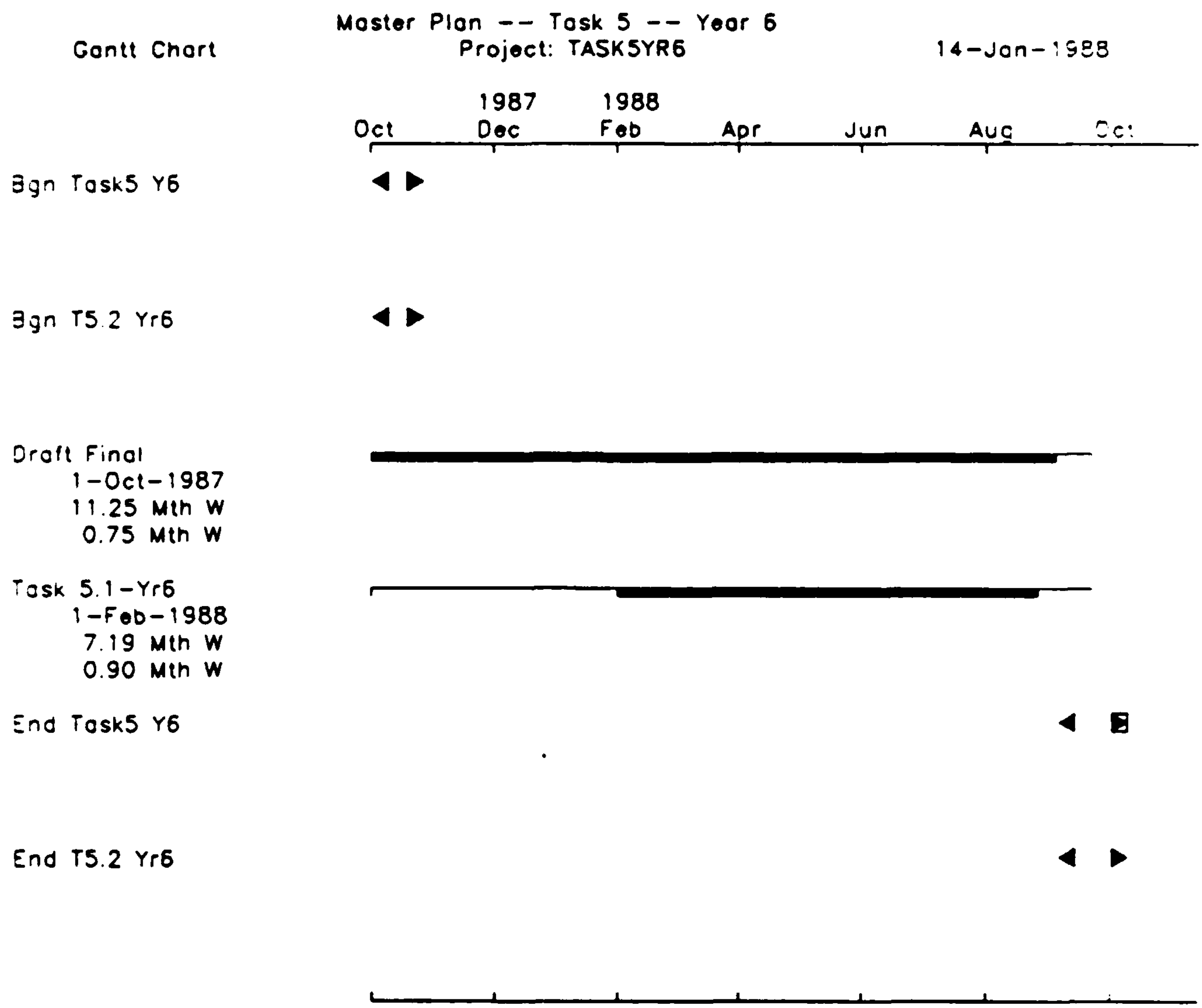

Figure D-5. Task 5 - Gantt Chart

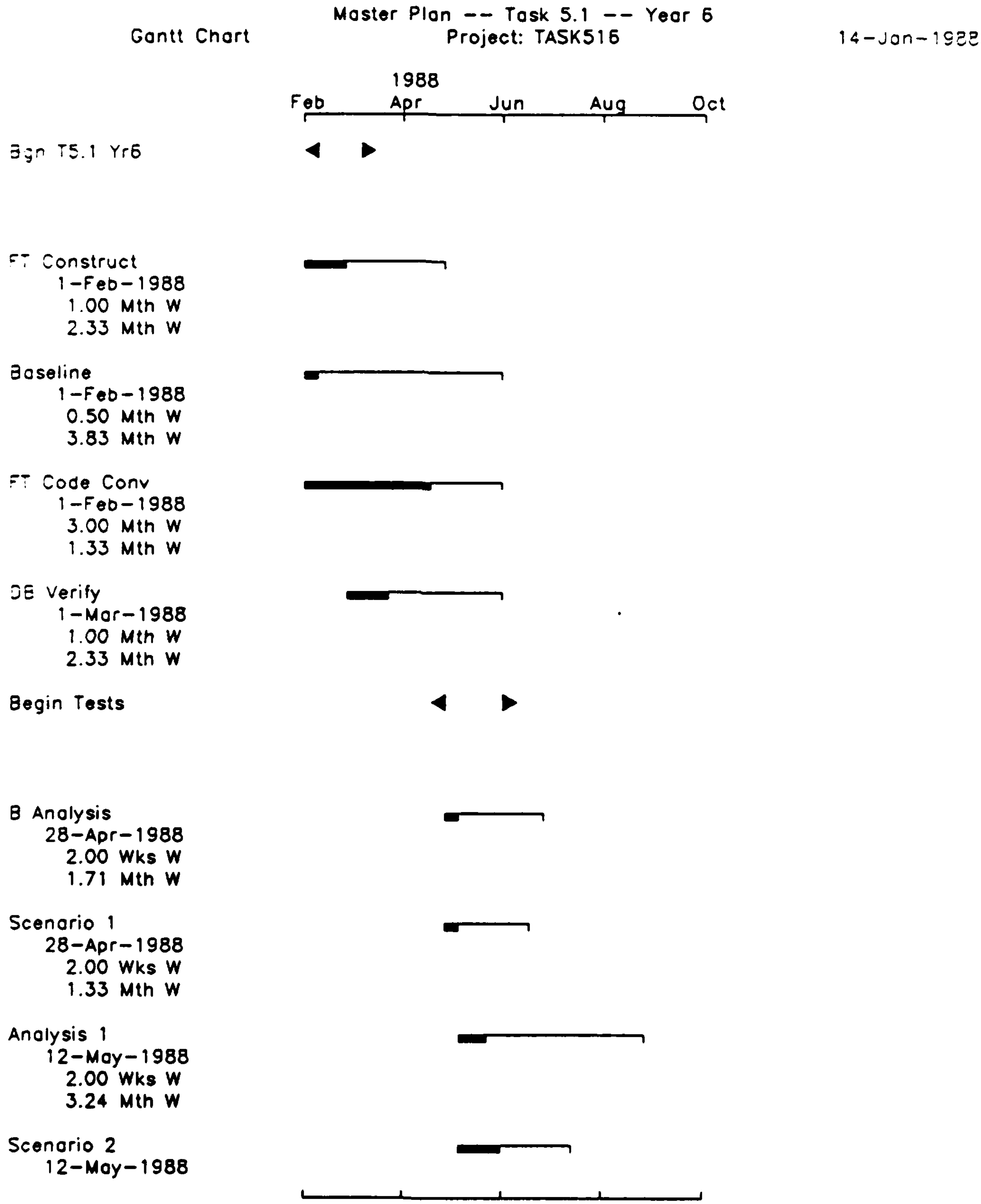

Figure D-5 (Cont'd). Task 5 - Gantt Chart

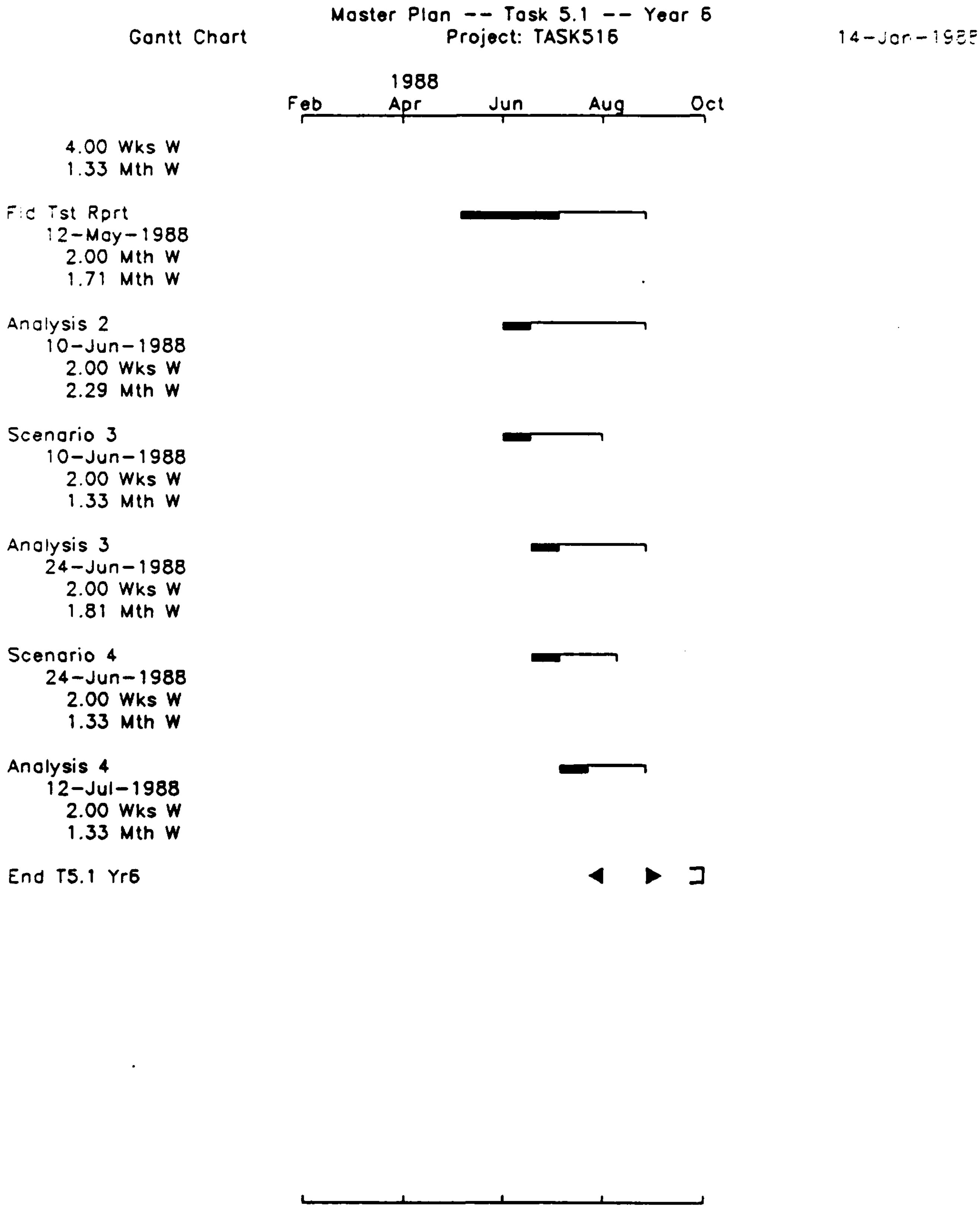

Figure D-5 (Cont'd). Task 5 - Gantt Chart

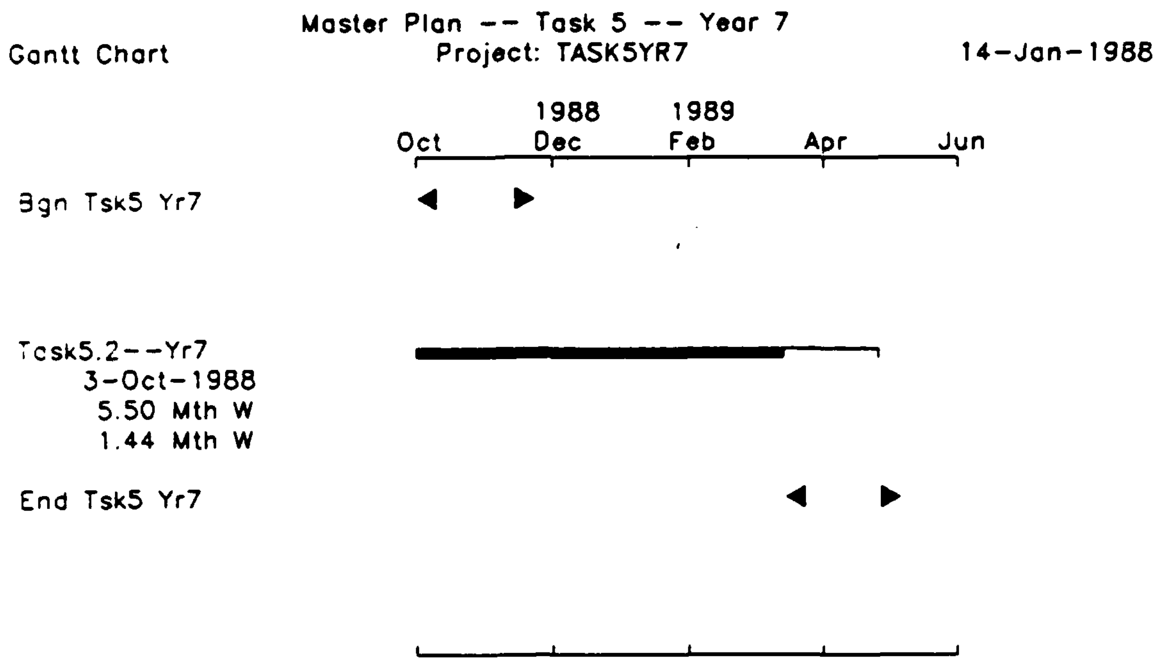

Figure D-5 (Cont'd). Task 5 - Gantt Chart

TABLE D-5

TASK 5 - TASKING

Master Plan -- Task 5 -- Year 6

Allocations by Task 19-Jan-1988

Task name	Task start date	Resource name	Resource quantity
Analysis 1	12-May-1988	OR Analyst	0.100
Analysis 1	12-May-1988	Prog Analyst	0.200
Analysis 1	12-May-1988	Project Mgr	0.100
Analysis 1	12-May-1988	Stat Analyst	0.300
Analysis 2	10-Jun-1988	OR Analyst	0.300
Analysis 2	10-Jun-1988	Prog Analyst	0.200
Analysis 2	10-Jun-1988	Project Mgr	0.100
Analysis 2	10-Jun-1988	Stat Analyst	0.100
Analysis 3	24-Jun-1988	OR Analyst	0.100
Analysis 3	24-Jun-1988	Prog Analyst	0.200
Analysis 3	24-Jun-1988	Project Mgr	0.100
Analysis 3	24-Jun-1988	Stat Analyst	0.300
Analysis 4	12-Jul-1988	OR Analyst	0.100
Analysis 4	12-Jul-1988	Prog Analyst	0.200
Analysis 4	12-Jul-1988	Project Mgr	0.100
Analysis 4	12-Jul-1988	Stat Analyst	0.300
B Analysis	28-Apr-1988	OR Analyst	0.100
B Analysis	28-Apr-1988	Prog Analyst	0.200
B Analysis	28-Apr-1988	Project Mgr	0.100
B Analysis	28-Apr-1988	Stat Analyst	0.300
Baseline	1-Feb-1988	Prog Analyst	0.200
Baseline	1-Feb-1988	Project Mgr	0.100
Baseline	1-Feb-1988	Stat Analyst	0.200
DB Verify	1-Mar-1988	DB Analyst	0.100
DB Verify	1-Mar-1988	OR Analyst	0.250
DB Verify	1-Mar-1988	Prog Analyst	0.250
DB Verify	1-Mar-1988	Project Mgr.	0.100
Draft Final	1-Oct-1987	OR Analyst	0.050
Draft Final	1-Oct-1987	Prog Analyst	0.200
Draft Final	1-Oct-1987	Project Mgr	0.050
Draft Final	1-Oct-1987	Stat Analyst	0.050

TABLE D-5 (CONT'D)

TASK 5 - TASKING

Master Plan -- Task 5 -- Year 6

Allocations by Task 19-Jan-1988

Task name	Task start date	Resource name	Resource quantity
Fld Tst Rprt	12-May-1988	OR Analyst	0.100
Fld Tst Rprt	12-May-1988	Prog Analyst	0.200
Fld Tst Rprt	12-May-1988	Project Mgr	0.300
Fld Tst Rprt	12-May-1988	Stat Analyst	0.100
FT Code Conv	1-Feb-1988	OR Analyst	0.050
FT Code Conv	1-Feb-1988	Prog Analyst	0.400
FT Code Conv	1-Feb-1988	Project Mgr	0.050
FT Code Conv	1-Feb-1988	Stat Analyst	0.050
FT Construct	1-Feb-1988	DB Analyst	0.100
FT Construct	1-Feb-1988	OR Analyst	0.200
FT Construct	1-Feb-1988	Prog Analyst	0.200
FT Construct	1-Feb-1988	Project Mgr	0.100
Scenario 1	28-Apr-1988	OR Analyst	0.300
Scenario 1	28-Apr-1988	Prog Analyst	0.800
Scenario 1	28-Apr-1988	Project Mgr	0.100
Scenario 1	28-Apr-1988	Stat Analyst	0.100
Scenario 2	12-May-1988	OR Analyst	0.100
Scenario 2	12-May-1988	Prog Analyst	0.800
Scenario 2	12-May-1988	Project Mgr	0.100
Scenario 2	12-May-1988	Stat Analyst	0.300
Scenario 3	10-Jun-1988	OR Analyst	0.300
Scenario 3	10-Jun-1988	Prog Analyst	0.800
Scenario 3	10-Jun-1988	Project Mgr	0.100
Scenario 3	10-Jun-1988	Stat Analyst	0.100
Scenario 4	24-Jun-1988	OR Analyst	0.300
Scenario 4	24-Jun-1988	Prog Analyst	0.800
Scenario 4	24-Jun-1988	Project Mgr	0.100
Scenario 4	24-Jun-1988	Stat Analyst	0.100

TABLE D-5 (CONT'D)

TASK 5 - TASKING

Master Plan -- Task 5 -- Year 7

Allocations by Task 19-Jan-1988 Page 1

Task name	Task start date	Resource name	Resource quantity
		OR Analyst	0.400
		Prog Analyst	0.800
		Project Mgr	0.400
		Stat Analyst	0.400

TABLE D-6

TASK 5 - TASK DESCRIPTIONS

Master Plan -- Task 5 -- Year 6

Task & Milestone List 19-Jan-1988

Task name	Start date	Planned duration	Planned finish	Description	Slack
Analysis 1	12-May-1988	2.00 Wks W	25-May-1988	Evaluate Results of Test Case #1	4.15 Mth W
Analysis 2	10-Jun-1988	2.00 Wks W	23-Jun-1988	Evaluate Results of Test Case #2	3.20 Mth W
Analysis 3	24-Jun-1988	2.00 Wks W	11-Jul-1988	Evaluate Results of Test Case #3	2.73 Mth W
Analysis 4	12-Jul-1988	2.00 Wks W	25-Jul-1988	Evaluate Results of Test Case #4	2.25 Mth W
B Analysis	28-Apr-1988	2.00 Wks W	11-May-1988	Evaluate Baseline Results	2.63 Mth W
Baseline	1-Feb-1988	0.50 Mth W	15-Feb-1988	Execute Baseline Simulation	4.75 Mth W
Begin Tests	27-Apr-1988		27-Apr-1988	Begin Executing Field Test Scenarios	2.25 Mth W
Bgn T5.1 Yr6	1-Feb-1988		1-Oct-1987	Begin Field Test	2.25 Mth W
Bgn T5.2 Yr6	1-Oct-1987		1-Oct-1987		0.76 Mth W
Bgn Task5 Y6	1-Oct-1987		1-Oct-1987	TASK 5: Field Test and Implementation Plan	0.76 Mth W
DB Verify	1-Mar-1988	1.00 Mth W	29-Mar-1988	Verify Accuracy of Field Test Data Base	3.25 Mth W
Draft Final	1-Oct-1987	11.25 Mth W	8-Sep-1988	Item 0002BC: Draft Final Technical Report w/ Associated Documenation	0.76 Mth W
End T5.1 Yr6	25-Jul-1988		25-Jul-1988	Completion of Test Scenarios	2.25 Mth W
End T5.2 Yr6	8-Sep-1988		8-Sep-1988		0.76 Mth W

TABLE D-6 (CONT'D)

TASK 5 - TASK DESCRIPTIONS

Master Plan -- Task 5 -- Year 6

Task & Milestone List 19-Jan-1988

Task name	Start date	Planned duration	Planned finish	Description	Slack
End Task5 Y6	8-Sep-1988		8-Sep-1988	Completion of Field Test	0.76 Mth W
Fld Tst Rprt	12-May-1988	2.00 Mth W	13-Jul-1988	Write Results of Field Test	2.63 Mth W
FT Code Conv	1-Feb-1988	3.00 Mth W	27-Apr-1988	Perform Specialized Code Conversions for Field Test	2.25 Mth W
FT Construct	1-Feb-1988	1.00 Mth W	29-Feb-1988	Build Field Test Data Base	3.25 Mth W
Scenario 1	28-Apr-1988	2.00 Wks W	11-May-1988	Test Case #1--Alternate Applicant Characteristics	2.25 Mth W
Scenario 2	12-May-1988	4.00 Wks W	9-Jun-1988	Test Case #2--Assign Applicants to Actual Distributions	2.25 Mth W
Scenario 3	10-Jun-1988	2.00 Wks W	23-Jun-1988	Test Case #3: Introduction of New Weapon System	2.25 Mth W
Scenario 4	24-Jun-1988	2.00 Wks W	11-Jul-1988	Test Case #4--Mobilization Scenario	2.25 Mth W

TABLE D-6 (CONT'D)

TASK 5 - TASK DESCRIPTIONS

Master Plan -- Task 5 -- Year 7

Task & Milestone List 19-Jan-1988

Task name	Start date	Planned duration	Planned finish	Description	Slack
Bgn Tsk5 Yr7	1-Oct-1988		1-Oct-1988		1.40 Mth W
End Tsk5 Yr7	20-Mar-1989		20-Mar-1989		1.40 Mth W
Task5.2--Yr7	3-Oct-1988	5.50 Mth W	20-Mar-1989	Item 000280: Final Technical Report	1.40 Mth W