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CAREER STRATEGY LONGITUDINAL EVALUATOR (CASTLE)

Sally J. Van Nostrand

PERSONNEL UTILIZATION TECHNICAL AREA

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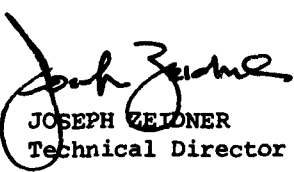
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FOREWORD

The Army Research Institute for the Behavioral and Social Sciences (ARI) pioneered the development of computer modeling of Army personnel management systems and officer career paths. The model described in this report, Career Strategy Longitudinal Evaluator (CASTLE), was developed for the Army Military Personnel Center (MILPERCEN) to use in producing decision data for newly developed personnel management policies for Engineer officers. CASTLE uses simulated officer data to model a variety of assumptions (input by MILPERCEN) and produce longitudinal results (several tours or assignments for each officer). MILPERCEN has indicated that CASTLE will be used to evaluate alternatives proposed by other specialties for solving within-specialty management problems.

The speed with which CASTLE was developed owes a great deal to MILPERCEN cooperation, particularly from LTC C. Hilton Dunn. LTC Dunn was unusually encouraging and responsive to ARI needs, allowing ARI to become totally cognizant of all MILPERCEN problems and needs, freely answering every question, and providing additional personnel to program and develop data input. CPT Edward Wright provided outstanding programming support; his innovative ideas contributed substantially to the model design and timely program completion was due to his superior programming techniques as well as his dedication to the project. All his work was contributed while he attended the Engineer Officer Advanced Course (EOAC) at Fort Belvoir, Va. CPT David Schnabel, also a student at EOAC, provided vital assistance and professional judgment in categorizing jobs and computing input parameters from more than 4,000 Officer Record Briefs and from hundreds of MILPERCEN computer sheets.

ARI's technical advisory service to MILPERCEN on this project was accomplished under Army FY 80 Project 2Q163731A792.


JOSEPH ZELNER
Technical Director



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CAREER STRATEGY LONGITUDINAL EVALUATOR (CASTLE)

BRIEF

Requirement:

To develop a method for evaluating long-term system effects of alternative new policies, prior to implementation, for managing officer personnel.

Procedure:

A computerized personnel assignment model was developed. Based on assumptions input by the user, the model (CASTLE) created simulated officer data. Using additional user-created assumptions, CASTLE assigned the simulated officers to a series of different jobs. The general model objective and constraint equations are discussed.

Four alternatives were developed to determine the feasibility of using CASTLE for personnel management policy evaluation and comparison. As a baseline, one simulation represented current officer assignment policies. Three others represented alternative methods being considered. The four alternatives were evaluated with CASTLE, and the results are discussed.

Findings:

The alternative that represents current practice produced outcomes consistent with empirical data from the Army Military Personnel Center (MILPERCEN). The outcomes of other alternatives were somewhat different than predicted by personnel planners. Examination of the data showed that the data CASTLE produced were more realistic than data produced by subjective judgments.

Utilization of Findings:

The model produces valuable data on system effects of personnel management strategies. CASTLE has been installed on a computer at MILPERCEN; initial use has produced evaluation data on new policies developed for the Engineer specialty. Present plans include using CASTLE to develop policies for other officer specialties.

PRECEDING PAGE

CAREER STRATEGY LONGITUDINAL EVALUATOR (CASTLE)

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CAREER STRATEGY LONGITUDINAL EVALUATOR (CASTLE)

INTRODUCTION

This report describes the need for and development of a computerized personnel assignment model, the Career Strategy Longitudinal Evaluator (CASTLE). CASTLE was designed to help decisionmakers choose among alternative, within-specialty personnel management policies by projecting the long-term system effects of each alternative.

During the last several years, the U.S. Army Military Personnel Center (MILPERCEN) has developed many large models to aid personnel decisionmakers. Most of these models are designed to allocate personnel among the various specialties or to assign personnel to the major commands. But military personnel managers recognize that goals of within-specialty personnel management policies sometimes seem to be disparate from overall Army personnel management goals. With the present problem of attracting and retaining personnel, there is a growing apprehension that many qualified officers, who would otherwise remain in the military, are resigning because they feel their assignments do not contribute to professional growth and development. Therefore, MILPERCEN is beginning to develop new personnel management policies that provide guidance for within-specialty job assignments and fit the major goals of the Officer Personnel Management System (OPMS): (a) Insure adequate job/skill matching; (b) offer individual officers job sequences that prepare them for the next higher level of responsibility (career strategy); (c) provide equitable promotion opportunity; and (d) improve independent within-specialty personnel management.

The purpose of the project was to evaluate alternative policies designed to alleviate career management problems in the Engineer officer specialty. Many other OPMS specialties have similar within-specialty problems; therefore, CASTLE was designed to be non-specialty-specific. CASTLE is expected to be useful in evaluating new management techniques within the other OPMS specialties.

This report reviews the unique aspects of OPMS and describes the CASTLE model. Appendix A provides a glossary of terms used throughout this paper; Appendix B shows the complete set of data summarized in the report.

BACKGROUND

Dual Specialties and Utilization Rates

Prior to 1972, officers were assigned to one of the Army branches when they were commissioned. They normally stayed in that branch throughout their career and expected their assignments to be within it. But there were many job requirements that were not related to any specific branch, particularly at the more senior grades. Assignment to these jobs or to jobs in other branches was perceived by some officers as a hinderance to their career development. For example, infantry officers trained to fight

and lead troops felt their backgrounds were not adequately used when serving in management or analytic jobs, and that they felt they had not been adequately trained for these other jobs. Since there was no discipline for assigning an officer to a non-branch-oriented job, it was possible for an officer to receive a series of assignments so different from one another that one assignment did not provide relevant experience for another, nor were the assignments in a logical career progression.

The present OPMS was expected to alleviate these problems. All jobs that seemed related in terms of duties or background requirements were categorized into groups called specialties (there are more specialties than there were branches). From available data it seemed that both officer and Army requirements would be met if (a) every officer served in two different specialties, and (b) no officers were assigned outside of those two specialties. Advantages would be the following:

1. Officers would know early in their careers (eighth year) what their additional specialty would be and would have an opportunity to get specific training for the specialty;
2. Officers could be considered for promotion in either specialty;
3. Assignments would fit a predesignated sequence (and therefore be more logical and more acceptable); and
4. No officer would have assignments in more than two specialties.

OPMS was initiated in 1972, and the system was implemented during the next several years. Creative strategies and policies to make OPMS function as intended are still evolving. A major departure from previous officer management strategies is the concept of the second specialty (presently called non-accession specialty), which is assigned to officers after they become skilled in their accession specialty (assigned at time of commissioning). Ideally, during the rest of their careers, their assignments would then alternate between the two specialties. Officers in accession specialties with relatively few field grade positions in proportion to the number of company grade positions would expect about two-thirds of their field grade assignments to be in their non-accession specialty. However, officers in accession specialties with a high proportion of field grade positions would expect only about one-third of their assignments to be in their non-accession specialty. The Army average would be 50% in each of two specialties.

The dual-specialty concept corrected grade/requirements imbalances in the combat arms specialties of Infantry, Armor, and Field Artillery, specialty codes (SC) 11, 12, and 13. These are the largest specialties; they have many company-grade requirements and relatively few field-grade requirements. Figure 1 shows the relative proportion of SC 11, 12, and 13 officers needed to fill specialty job requirements.

Utilization rate (U) is the measure of how well a specialty is meeting the OPMS requirement for officers to serve in both their non-accession and accession specialties. U is computed for each grade by dividing the number of authorized specialty positions by the number of accession officers

assigned to specialty positions (U = positions/officers). The MILPERCEN goal is that U will range between 33% and 67% for the senior captains (CPT) through colonels (COL); the average should be 50%. Assignment in both specialties is an established and well disseminated requirement for career success.

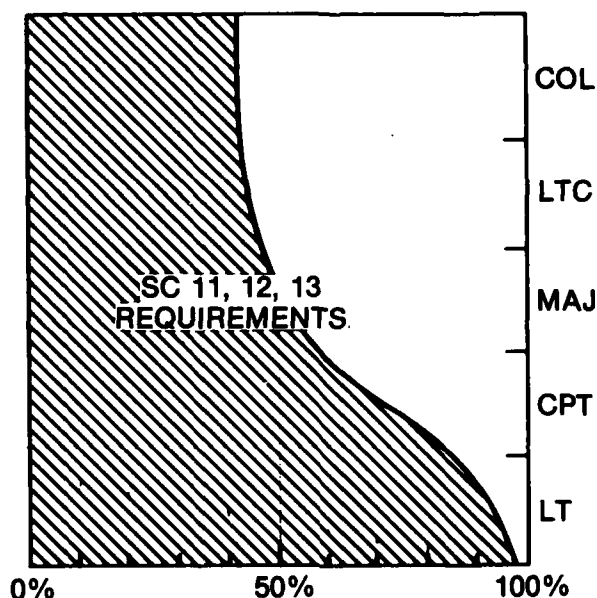


Figure 1. UTILIZATION RATE OF SC 11, 12, AND 13

The Engineer specialty (SC 21), another combat arms specialty, has extremely high utilization rates. There is a noticeable difference in specialty job requirements between SC 21 (Figure 2) and SC 11, 12, and 13 (Figure 1). For SC 21, the percentage of senior COL positions is nearly equivalent to the percentage of lieutenant positions, and the U is 100% in the senior captain and junior major (MAJ) range. If OPMS functioned as originally anticipated, many of the positions would be filled by non-accession officers from specialties such as those shown in Figure 1. However, at present the majority of the SC 21 positions are filled with officers who have SC 21 as their accession specialty (2lxx); few positions are filled with non-accession (xx21) officers.

OPMS was instituted using subjective data about the effects of the system on the various specialties. Using data for all specialties similar to that in Figures 1 and 2, it was anticipated that the dual-specialty requirement would assure that all jobs were filled with qualified officers and that a suitable job would be available for every officer. However, at that time the models now used for across-specialty management did not exist. Because there are no other personnel systems (enlisted, other service, or civilian) that use the dual-specialty concept, there were no historical data to help evaluate the feasibility of the concept.

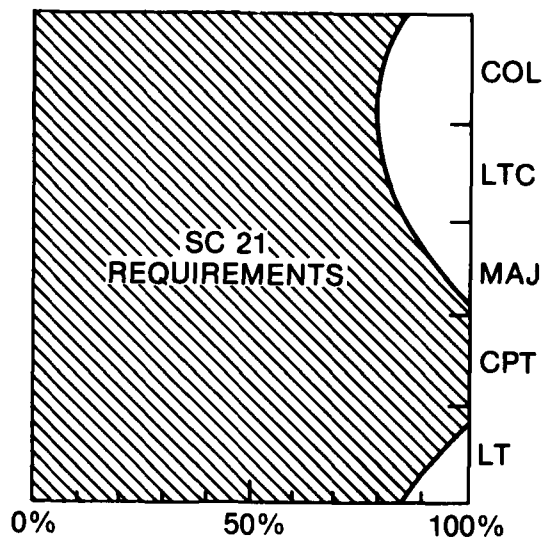


Figure 2. SC 21 UTILIZATION RATE

Engineer Professional Development Study

The numerous experience and education requirements in the technical specialties make it difficult to fulfill all requirements of both the specialty and OPMS. For example, technical requirements of many high-level SC 21 jobs make it difficult for a non-accession officer to competently fill them, and it is difficult for the 2lxx officer to stay proficient in engineering while serving in an xx2l position. Jobs such as District and Division Engineer (filled by colonels and general officers) require that the officer be a highly qualified engineer (preferably with certification as a Professional Engineer) and have additional skills, such as procurement and resource management, as well as the traditional skills of combat and leadership.

In August 1979 the Chief of Engineers (COE) requested that MILPERCEN revise its management practices. His perception seemed to be that engineers were required to meet so many other requirements that the senior officers frequently did not have the proper background to prepare them for District and Division Engineer positions. The COE felt that more construction management (CM) experience at the major and lieutenant colonel (LTC) levels was a necessity. Giving high priority to CM assignments could produce unknown perturbations throughout the Engineer specialty. Therefore, the Engineer Professional Development Study (EPDS) was initiated in September 1979. The purposes of EPDS were to (a) assess the structure of the Engineer officer corps; (b) determine whether Engineers could be better managed within the present constraints of OPMS, and, if not, (c) determine what modifications were necessary to meet the concerns of the COE, the needs of the Army, and the needs of individual officers.

A study group of Army War College (AWC) students was scheduled to furnish alternative management policies in May 1980. Meanwhile, MILPERCEN

furnished data to the AWC group, developed additional alternatives, and asked for help from the Army Research Institute for the Behavioral and Social Sciences (ARI) in evaluating the alternatives. Since the alternatives developed by MILPERCEN and the AWC group would contain subjective judgments, the original expectation was that ARI would assess the MILPERCEN computerized models and determine how they could be used to provide data for choosing among the alternatives.

Need for Evaluation Tools

It was quickly determined that MILPERCEN models predict (a) total U.S. Army officer requirements, (b) number of officers that must be recruited for each specialty, and (c) how many non-accession officers are needed by each specialty. However, there were no models that could be used to assess the numbers of officers with unique education/experience background to adequately fill different within-specialty jobs. Without a method of using objective data to project the long-term results of the subjectively developed alternatives, it would be impossible to choose among them. MILPERCEN needed within-specialty, long-term predictor or policy evaluation tools.

Since the COE had requested that every SC 21xx major and lieutenant colonel be assigned to at least one CM job, the first ARI task was to ascertain whether this assignment was possible. The Construction Management Maximization Model (CM³), a simple single-purpose transportation model, was developed to estimate the maximum number of SC 21xx officers who could have at least one CM tour prior to promotion to colonel.

An application of CM³, using gross estimates of the numbers of CM jobs, indicated maximizing CM experience was possible. However, examination of the outcome data revealed that the addition of the many constraints omitted from the model would probably render CM maximization (as a single objective) impractical. Specifically, if all other OPMS requirements were ignored, most officers could get one CM assignment; many of these had to be assigned as a captain rather than as a major or lieutenant colonel. CM³ could not determine whether CM could be maximized when all OPMS requirements were met, nor could it evaluate any of the myriad of other alternative recommendations that should be considered. These results showed that a general multi-purpose model that could predict the results of policies in concert with their environment (other OPMS and within-specialty personnel management policies) was needed.

CASTLE DEVELOPMENT

CASTLE Design and Implementation Criteria

The first design criterion for the new model, Career Strategy Longitudinal Evaluator (CASTLE), was that the model must account for policy interactions; that is, CASTLE should aid personnel planners in identifying policies that interact to (a) contribute to reaching desired goals, (b) detract or produce negative cumulative effects, and (c) have no effect or cancel each other.

Short-term policy effects can be estimated by experienced personnel planners. However, long-term effects of a variety of policies produce more interactions than can be estimated with noncomputerized prediction techniques. Therefore, the second and third CASTLE design criteria were that (a) it must be a computer model that (b) produced a longitudinal set of results.

After specifying the major design criteria, it was necessary to design implementation methods. The longitudinal effects criterion was relatively straightforward. The main module assigns a group of officers to a group of jobs. CASTLE simulates a series of assignments by cycles through the logic paths, reading a new set of input data before each cycle. These data, combined with data saved from previous cycles, specify the logic path used for the next assignment cycle. An assumption is made that an assignment will be a certain number of months; the number of months to be simulated divided by the tour length is the desired number of cycles. This number is a CASTLE input.

General specifications for simulating policy interactions are represented in two ways. One is a set of algorithms in CASTLE that are controlled by input parameters. These parameters control paths through CASTLE such as whether the policy is in effect or not; if it is in effect, whether it applies to all officers or to only certain groups; and when in the officers' careers it affects them. The other policy representation is by the rules for creating the input data. Developing the method for representing specific policies was the difficult task.

Descriptions of the major policies and a general description of the algorithms or input data development rules are in the following sections. An "option" means one or more algorithms are in CASTLE and are selected for use by input parameters.

Attrition and Promotion Rates. Unlike civilian personnel systems, officers managed by OPMS enter the military at the lowest rank and progress upward; higher rank slots are not filled by people from outside the system. Therefore, the number of people who enter during a specific 1-year period (year group) decreases over time as officers leave the military. Some of the attrition rate can be attributed to the Army officer promotion system. For example, some assignments are considered "gates" through which an officer must pass; an officer who does not receive these important assignments is usually not promoted, and an officer who is not promoted within a certain period is required to leave the service. CASTLE must approximate actual attrition rates. When an alternative specifies a gate, more officers must be lost from the group who did not go through the gate assignments than from the group who did. CASTLE algorithms that simulate gates are controlled by input data. Attrition rates are input for each assignment cycle.

Officer and Job Types. OPMS attempts to treat all officers equally. However, real-world requirements necessitate some differentiation. Although some Engineer jobs require a mathematics or science degree, many can be filled by officers without regard to their degree. Other jobs can be performed adequately only by officers with engineering degrees. Because it is increasingly difficult to recruit the number of officers needed from engineering students, a career strategy must be guaranteed for all officers in

the Engineering specialty, regardless of their degrees. CASTLE, therefore, is designed to fill jobs from the entire group, or as an option to choose job incumbents first from among those who "should" fill the positions. As in the actual system, officers are not completely restricted from any job; if vacancies exist and there are not enough officers with the proper credentials, the jobs will be filled from the pool of less qualified personnel.

Officer Potentials for Job Types. An assignment algorithm needs a criterion for making assignments. Computerized algorithms often use test scores as the criterion. Army officers, however, are never assigned based on test scores. As with prior officer management systems, Army officers managed with OPMS are assigned based on a subjective combination of background history items such as education and experience, additional experience needed, and present Army requirements. For CASTLE, the input variable "potential" is used as the assignment criterion. If an alternative specifies that all officers should be equally considered for a job type, every officer's potential is set to the same value. Whether the value is high or low in comparison to potentials for other jobs depends on when the job should be assigned in the simulated period. If it should be an early assignment the beginning potential is set high (the criterion for assignment is that all officers should be assigned to the jobs for which their potential is highest). Conversely, if it is a job that should be assigned late in the career or only when nothing else is available, the beginning potential is set low.

An additional parameter, change in potential (CP), specifies whether the officer should be assigned to the job more than once. Examples of the use of potentials and CP will more clearly show the versatility provided by these parameters:

1. An alternative specifies every officer should serve in the job once, but no more than once unless there are no officers left who have not been assigned at least once: Set the beginning potential for the job high. The CP parameter is set to decrement the officer's potential by a large amount after the first assignment. That officer will not be assigned to that job again unless all other officers have been assigned to it and their potentials have been reduced by the same amount.
2. "Stovepiping" (single-tracking or constricting some officer group(s) to a few job types): Set the original potential for these officers high and the CP to a small decrement. The job potentials for the jobs the officers are restricted from are set low; these officers will not be assigned outside the stovepipe jobs unless there are not enough other officers. Other officers can be excluded from the stovepipe jobs by setting their beginning potentials to very low values.
3. Each officer is to serve in one, but only one, of several job types: Set the original potentials for all of these jobs high. Once an assignment to any one is made, an officer is excluded from another assignment in any of the jobs by decrementing all of the jobs by a large amount (large CP). The jobs to be included in this set are controlled by another input parameter.

Use of the potentials, CP, and similar job type parameters also permits some of the jobs to be treated as if they were a different specialty. This allows CASTLE to produce evaluative data on whether a specialty could be better managed as two separate specialties and whether providing dual-tracks within a specialty is desirable.

Number of Jobs Available of Each Type. Computation of the actual percentage of the total jobs of one type that are available for any given set of officers is a complicated process; it depends on the attrition rates for the time period, the number of months of the average tour, and the number of months officers are eligible for the job (which is in turn related to their rank and promotion rate). The entire number of jobs of each type is input. Then an adjustment parameter for each tour, computed from the percentage of available jobs, is input and CASTLE recomputes the actual number of available jobs of each type.

Insuring a Job for Every Officer. The assignment algorithm requires that the number of jobs equals the number of officers to be assigned. Therefore, one job type is treated as a "slack" variable and is normally the non-accession specialty job. When more jobs are needed for the officers, more are assigned to this job; if there are not enough officers to fill the specialty positions, the number assigned to this job is reduced by the necessary amount. Utilization rate (U) is computed from the number of officers assigned to this job type. One caveat should be stated: The assignment algorithm also requires that the number of jobs available of each type must be a positive integer. Therefore, the program will not work correctly if the number of slack jobs is allowed to go to zero or negative. With the current situation of fewer SC 21 officers than SC 21 jobs, a problem could arise if the input data are not carefully prepared. For the trials reported in later sections of this report, the number of xx21 officers expected was added to the number of 21xx officers. Therefore, the number of officers available was always larger than the number of SC 21 jobs.

The Assignment Algorithm

If scores on standard tests are available and can be used as assignment criteria, a numerical utility value can be developed for the assignment; and if the number of officers to be assigned equals the number of available jobs, the optimal assignment of a group of officers to a set of several types of jobs can be solved by the Ford-Fulkerson version of the Hungarian method (Ford & Fulkerson, 1956; Kuhn, 1955). This solution is stated as follows:

Let:

S_{ij} = utility value of assigning officer_i to job_j;

X_{ij} = binary variable set to 1 when officer_i is assigned to job_j and otherwise set to 0;

n = number of officers; and

m = number of jobs.

Then the objective function to be maximized is:

$$\sum_{i=1}^n \sum_{j=1}^m x_{ij} S_{ij} \quad (1)$$

and if A_{ij} , B_{ij} , and C_{ij} represent the scores (potentials) for the jobs (j) to which officers (i) have been assigned, where:

A_{ij} = highest potential for officer_i;

B_{ij} = potential that is tied for the highest potential for officer_i by at least one other potential;

C_{ij} = potential for job_j to which officer_i was assigned even though it was not the highest potential for officer_i;

a = number of officers assigned to their highest unique potential;

b = number of officers assigned to one of their highest potentials;
and

Q = quota or number of officers required for each job_j;

then the objective function can be restated as the partitioned equation:

$$\text{MAX} = \sum_{i=1}^a \sum_{j=1}^m x_{ij} A_{ij} + \sum_{i=a+1}^{a+b} \sum_{j=1}^m x_{ij} B_{ij} + \sum_{i=a+b+1}^n \sum_{j=1}^m x_{ij} C_{ij} \quad (2)$$

with the constraints:

$$\sum_{j=1}^m x_{ij} = 1, \text{ for officer}_i \quad (3)$$

$$\sum_{i=1}^n x_{ij} = Q_j, \text{ for job}_j \quad (4)$$

$$\sum_{j=1}^m Q_j = \sum_{i=1}^n \sum_{j=1}^m x_{ij} = N = n \quad (5)$$

where N is the number of officers to be assigned.

During the 1960s ARI developed a computerized version of this problem solution that uses the column constants technique (Brogden, 1954; Dwyer, 1957), a program named OTT. Using OTT, one set of assignments (assignments for one tour) could be simulated for each alternative. Although officers are never assigned on the basis of standard test scores as OTT requires, the scoring logic can be applied using other criteria such as presence of an engineering degree or prior assignment history. Since the alternatives would use a variety of different criteria, a more general term, potential, was chosen. The objective function to be maximized is the number of officers

(X_{ij}) assigned to $X_{ij}A_{ij}$ or $X_{ij}B_{ij}$ (jobs for officers' highest potentials). The assignment alternative that produced the smallest number of assignments in which officers were not assigned to jobs matching their highest criterion potential, $n - (a + b)$, is the optimum solution. In other words, the sum of $(a + b)$ is maximized, while $n - (a + b)$ should be as close to zero as possible.

Since OTT has been used as the standard for comparing other optimization techniques (Granda & Van Nostrand, 1980), has been the basis for other personnel assignment problems (Johnson, 1971), and has successfully been used in a prior ARI officer assignment program (Eastman, 1978; Fields, 1977a; Fields, 1977b), it seemed more reasonable to incorporate OTT as the assignment optimization algorithm than to develop an entirely new program. In fact, if assigning officers for one tour would have produced the required alternative evaluation data, the program developed by Eastman and validated by Fields could have been modified.

Necessary Model Expansion

One-tour utility values would not evaluate the long-term results of a series of tour assignments. Therefore, it was necessary to expand the logic to compute career paths for every officer. Using the logic of the general model and adding the variable, t , number of tours, the partitioned objective equation (from equation 2) becomes:

$$\text{MAX} = \sum_{k=1}^t \left[\sum_{i=1}^a \sum_{j=1}^m X_{ijk} A_{ijk} + \sum_{i=a+1}^b \sum_{j=1}^m X_{ijk} B_{ijk} + \sum_{i=a+b+1}^n \sum_{j=1}^m X_{ijk} C_{ijk} \right] \quad (6)$$

and the constraint equations (from equations 3, 4, and 5) become:

$$\sum_{k=1}^t \left(\sum_{j=1}^m X_{ijk} \right) = t \text{ for officer } i \quad (7)$$

$$\sum_{i=1}^n X_{ijk} = Q_{jk} \text{ for job } j \text{ in tour } k \quad (8)$$

$$\sum_{k=1}^t \left(\sum_{j=1}^m Q_{jk} \right) = \sum_{k=1}^t \left(\sum_{i=1}^n \sum_{j=1}^m X_{ijk} \right) = tN \quad (9)$$

Equations 6 through 9 assume an attrition rate of zero. For realism it is necessary to include a different attrition rate, R_k for each tour k , and an additional constraint is introduced:

$$N_{k-1} - (N_{k-1})(R_{k-1}) = N_k \quad (10)$$

The precise number of officers to be attrited and the officers to be chosen for attrition are randomly determined using a random number generator utility program from the computer software programs. Since the only

stochastic process is attrition simulation, the CASTLE program is best described as a deterministic model. It is written in standard FORTRAN and could be put on any computer system that has a FORTRAN compiler.

CASTLE does not actually assign officers using existing data. Input parameters are defined using assumptions about the alternative to be evaluated. These assumptions include variables such as expected number of officers of the desired types (experience, education, and so forth); number of different officer groups (including xx21 or non-accession); number of job types; number of jobs of each type; and the beginning potentials for each officer type for each job type. Using these input parameters, CASTLE produces an input data file of simulated officer data. After each set of assignments, an assignment history file is updated for each simulated officer. When all assignment cycles have been completed, a summary of the number of officers who received each job sequence is computed. The summary and the assignment history file (including those who left the military and were dropped from further CASTLE treatment) is printed. Figure 3 is a simplified diagram of the CASTLE program flow.

CASTLE Assumptions

CASTLE was designed to fill a specific need--evaluation of long-term system results of a number of personnel management policies. To provide the maximum amount of flexibility, all possibilities for which data existed or for which a reasonable expectation of future data availability existed were provided for, either in the model to be controlled with input data or in the rules for input data development. It is possible that future policies may have features that cannot be evaluated with CASTLE. However, except for three assumptions that may be limiting factors for some applications, CASTLE will handle policies that have been suggested to date. These assumptions are described below.

Assumption 1--Simultaneity. Availability of jobs and officers is assumed to be simultaneous.

The assumption of simultaneity represents a technique commonly used in operations research (OR): developing a structured solution to an unstructured problem (Chacko, 1976). OPMS, with its mass of variables, unknown interactions, and uncertain outcomes, is typical of unstructured management-decision problems amenable to OR solutions.

Although a description of the officer assignment process seems to be a description of a typical queuing problem (see Figure 4), the structured portions lend themselves to a transportation solution, that is, allocating resources where officer groups represent the supply sources. An OR solution is always an idealized solution. The insights provided while arriving at the solution normally provide insights to the unstructured real problem; the optimum solution may not be possible to realize, but certainly using the ideal solution as a goal is more helpful than having no quantifiable goal. Therefore, although CASTLE provides solutions that may not be possible to attain, its solutions can be used as personnel management goals.

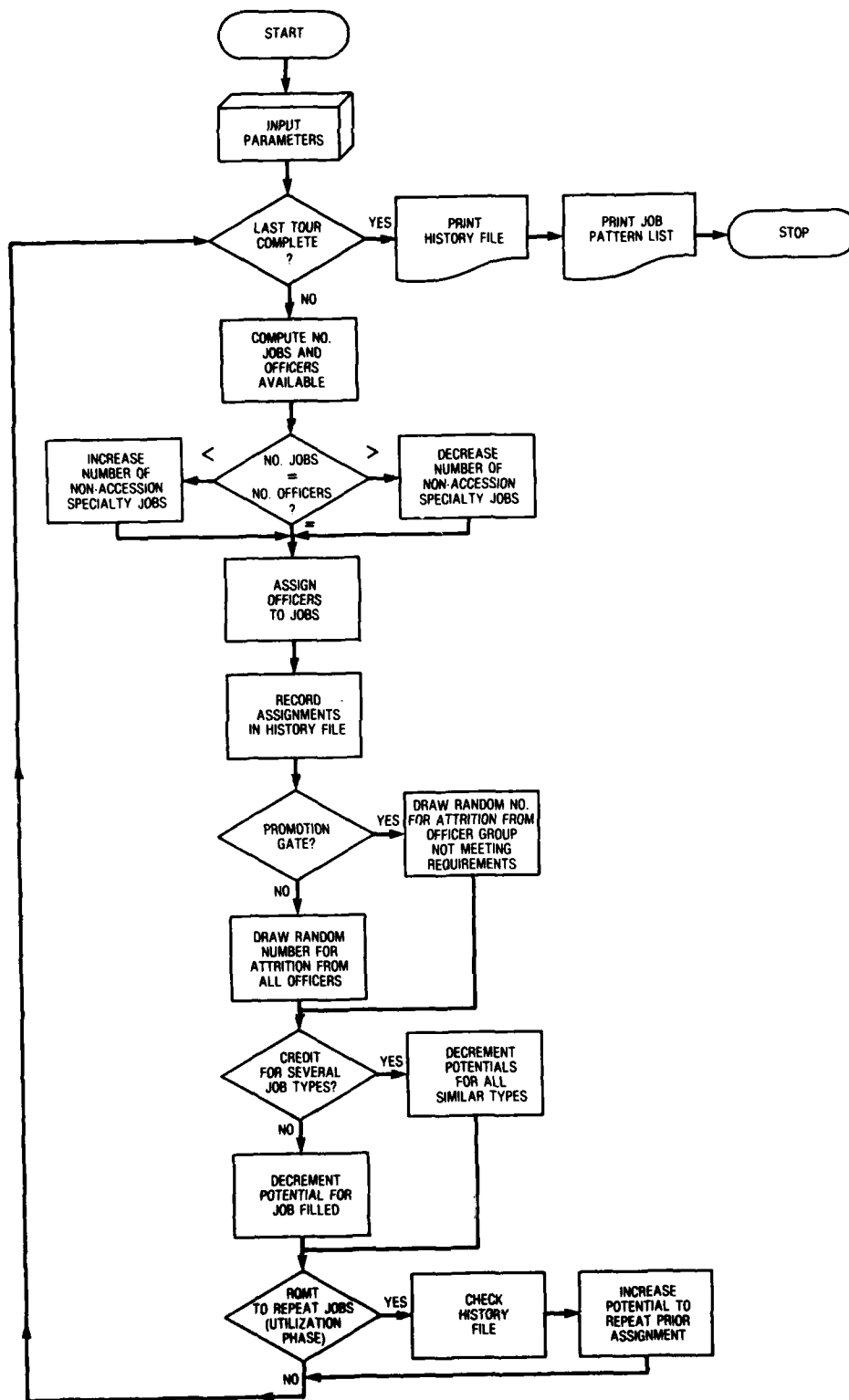


Figure 3. CASTLE FLOW DIAGRAM (SIMPLIFIED)

Operations Research	CASTLE	
Queue	Officers	Jobs
Arrives	Need jobs	
Service begins	Are assigned	Are filled
Instantaneously	Instantaneously	Instantaneously
If service person is available	If job is available	If officer is available

Figure 4. Officer and job availability compared to queueing problem.

There is more structure and simultaneity in OPMS than is readily apparent. Officers may join the Army and jobs may become vacant at any time. In reality, officers tend to be commissioned during the summer after college graduation. Although not mandated for the purpose, the Army training system tends to perpetuate the clustering of officers available for reassignment. The fixed schedules of Army officer schools and colleges periodically re-cluster the officers and therefore the jobs. Thus, a large percentage of both jobs and officers are simultaneously ready for assignment. Evidence supporting this assumption appears in the Utilization Rates section: A simulation of present OPMS policies produces utilization rates that approximate current officer utilization and the MILPERCEN-projected rates.

Assumption 2--Promotion Board Actions. Promotion Board actions are assumed correlated with new policy requirements.

If an implemented alternative forces officers into career paths that do not include command assignments, and promotion boards continue to prefer to promote officers with command experience, the long-term result may be less qualified senior officers than now exist (see Discussion section, Figure 6, Table 14, and Table B-12). This outcome would be the result of incorrect but possibly unpredictable assumptions. The gate option should be used to produce the anticipated results of undesirable promotion board actions--personnel management planners should establish both the worst and best case of proposed alternatives. An alternative that produces a slightly less desirable best case may be preferred if its worst case is only a little worse than its best case; such an alternative is definitely better than an alternative with a slightly better best case and an untenable worst case.

Assumption 3--Not Appropriate for Individual Assignment. CASTLE should not be used to determine individual officer assignments.

CASTLE was developed as a result of a need for new Army personnel management policies; a logical extension would be to use CASTLE to determine methods for fulfilling officers' needs. One obvious method would be to create career paths tailored to individuals' needs, which also fit Army requirements. However, a CASTLE modification would not be appropriate; The

design criteria for a model designed to evaluate longitudinal system effects are very different from criteria for computing optimal individual assignments. The "Assignment Algorithm" created by Eastman (1978) was specifically designed to optimally match officers and jobs using a variety of relevant criteria. It uses the same basic algorithm (OTT) as CASTLE, but develops the assignment criterion in an entirely different way (Fields, 1977a, 1977b). Although the Assignment Algorithm presently makes only one set of assignments, it could be further extended into a longitudinal model by incorporating the same type of several-tour expansion logic used for CASTLE.

AN APPLICATION OF CASTLE: A COMPARISON OF FOUR ALTERNATIVES

CASTLE is designed to be used as an evaluative tool with which planners can ask "what if" questions and explore the results or consequences of personnel management changes. In that context, the adaptability of the model, its sensitivity to change, and the credibility of the outcomes are of major concern. Recognizing these concerns, four alternatives were defined as candidates for testing the feasibility of using CASTLE as an evaluation tool. To facilitate comparison, several assumptions were specified that certain management practices/policies would stay the same while others would vary; the policies expected not to change were treated as assumptions. Hypotheses concerning the results of these assumptions can be explored because they are readily modified by changing input parameters. After completing the four computer runs for a sample alternative comparison, additional runs were made to test CASTLE sensitivity to some of these assumptions (described in the Sensitivity Analysis section). Each assumption and an optional method for treating it are described in the following section.

Assumptions Used in This Application

Assumption 1. All officers are assumed average; different career paths for upper-, middle-, and lower-third officers are not created. Option. Use not-yet-identified rules to create different input parameters for number of officers of each type and number-of-jobs adjustment parameters. Then run CASTLE once for each officer type for each alternative.

Assumption 2. Job potentials and the change potential (CP) variables (assignment criteria) are set high or low with no in-between values: potentials for jobs are set to high, equivalent values for all jobs an officer may hold under the rules for the alternative evaluated; jobs an officer should not hold are set to low, but equivalent, values. While creating the rules for any alternative, it would be possible to designate the relative worth of assignments (Kneppreth, Gustafson, Leifer, & Johnson, 1974; Kneppreth, Hoessel, Gustafson, & Johnson, 1978) across a range of values for both potentials and CP parameters. Option. Based on objective data such as "worth," using techniques described by Kneppreth et al., set potentials and CPs for each officer group for each job type to a range of values.

Assumption 3. Only long tours of an average length are treated. Option. Before computing number of jobs available for each tour, determine average number of short tours and number of jobs available for each. Then add an appropriate number of tours and define the number-of-jobs adjustment parameters.

Assumption 4. Each officer receives credit for only one job type in each tour. The real-world situation may be that officers actually receive credit for two jobs during one tour (reassignment without a change in duty station). Option. Of several ways of treating the situation, the easiest is to separate jobs and officers into two groups based on the number who actually get two job credits during one tour. One officer group is put through the program with data on jobs similar to that used in the four alternatives in this report but reduced by the numbers of jobs reserved for the other group. The two-credit group is given their credit by showing more tours with at least one set of present tours divided into two tours to reflect serving in two jobs. An additional CASTLE run produces the data for the two-credit group. By using additional CASTLE runs with different data in each, many variations may be treated.

Assumption 5. The Transient/Holdee/Student (THS) account is treated as a job category. Therefore, although it is probably unrealistic, some officers were assigned to this category more than once. Option. Set the CP to such a large decrement that it precludes the possibility of a second assignment.

Assumption 6. Only one year-group is assigned. Option. Should it be desired to simulate assignments of several year-groups at one time, the methodology for treating different groups based on background characteristics could be expanded. For example, in this report one year-group is divided into as many as three different officer types (groups). If it were desired to have three different types of officers in each of four year-groups, the total number of officer groups would be 12; it would be necessary to create 12 different sets of potentials and CPs, and the number-of-jobs adjustment parameters would be recomputed. Note, however, that all officers would be assigned and reassigned simultaneously. If this simultaneity is unacceptable, it would be better to run CASTLE once for each year-group.

Assumption 7. Non-accession specialty designation is assumed to occur at the end of the sixth year (different from the present policy of at the end of the eighth). Implicit here is the assumption that the first 6 years of SC 21 officer careers are similar, and that their accession specialty qualification has been completed during those years. In addition, all alternatives assume that non-accession engineers could be made available as soon as they are qualified in their accession specialty, also assumed to be 6 years. The officers used as input include both accession (2lxx) and non-accession (xx2l) engineers. Option. Whether an alternative is desirable if the OPMS policy of eighth year second specialty designation is not changed can be verified easily by changing input data. Also, xx2l officers can be separated from 2lxx officers by treating each as a separate group. Other parameters could be different for each group; for example, the potential for other specialty jobs could be higher for xx2l officers and/or the CP could be smaller.

Assumption 8. Attrition rates were assumed to be (a) equal for all jobs, and (b) the same as recent rates for each year of service. It is possible (perhaps probable) that attrition rates are different for each job type, and/or different career paths produce different attrition rates. Since there is now no available data to show what these differences are, the SC 21 average for each year of service was used. Option. Attrition rates for each job for each tour are separate inputs. Therefore, if additional research provides more realistic data, the data can easily be incorporated. An additional option is to check an alternative before adopting it by using different attrition rates to verify whether the alternative is still viable if attrition rates change.

Assumption 9. Projected number of officers in 1990 was used. The majority of tables and comparisons in this report are based on MILPERCEN projections of available officers in 1990. These data include (a) present SC 21 attrition rates; (b) number of 2lxx officers to be commissioned; and (c) xx21 officers added at the end of the sixth year (the number of xx21 officers now projected is increased, using attrition rates, to the number required to produce the number projected for the eighth year). The combination of 2lxx and xx21 officers is called the 1990 inventory. Option. Since it may be impossible to accession the expected number of 2lxx officers, or the other specialties may not be able to provide the number of xx21 officers desired, alternatives that seem viable should be checked using different numbers of officers. For comparison, CASTLE was used to evaluate the alternatives using the 1980 inventory; results are described in a later section.

Assumption 10. The number of jobs used for most comparisons is the number of jobs now filled by MILPERCEN. Due to the current officer shortage, many authorized positions are left vacant. Option. Additional assumptions concerning the percentage of authorized or required jobs that will be filled should be made concurrently with assumptions concerning number of officers available.

Assumption 11. The length of each tour is assumed to be 30 to 36 months, and five tours were simulated. Therefore, the time simulated is 12.5 to 15 years beyond the end of the sixth year (7 through 19.5 to 22 years). Option. The tour length is an assumption only; it is not input to CASTLE. The number of tours is input and can be any number, depending upon the time simulated and the tour length assumption.

Table 1 summarizes the two sets of assumptions used in this application of CASTLE.

Description of Alternatives

There are four general types of SC 21 jobs: troop, Engineer specific not including topological (TOPO), TOPO, and nonspecialty specific jobs which must be filled by Engineer officers. Additional jobs include various student assignments. In the example comparison of alternatives, the four alternatives and success criteria are described in terms of the categories shown in Figure 5. Categories III and IV overlap to some extent; the alternative specifies the divisions.

Table 1

Assumptions Used in this Application of CASTLE

Assumption	Option		
	Change input parameters	Change input parameters and additional runs	None--inherent to CASTLE
<u>CASTLE assumptions</u>			
1. Simultaneity			X
2. Promotion Board actions			X
3. Not appropriate for individual assignment			X
<u>Application assumptions</u>			
1. Average officer		X	
2. Potentials and change potential parameters artificial	X		
3. Long, average length tours		X	
4. One job per tour		X	
5. THS assigned more than once	X		
6. One year-group		X	
7. Non-accession designation, end of 6th year	X		
8. Historical attrition rates	X		
9. Projected 1990 number of officers	X		
10. Current filled jobs	X		
11. Tour length/number tours	X		

Category	Description
I	Not Engineer specialty specific but required for Army support (sometimes cross-fertilization)
A	Recruiting, ROTC & USMA teaching, etc.
B	Non-accession specialty assignments
C	Engineer officer required--Headquarters, Department of Army, MILPERCEN, ARI, etc.
II	Engineer troop assignment
A	Battalion command
B	Other unspecified troop assignments
III	Engineer specialty specific
IV	Engineer specialty specific
V	Topological engineering (TOPO)
VI	Transient, Holdee, and Student (THS)

Note. Categories III and IV overlap; division is defined by alternative assumptions and description.

Figure 5. Categories of Engineer (SC 21) jobs.

Table 2 summarizes the number of officers and jobs used in the comparisons (before adjustment; see previous section, Number of Jobs Available of Each Type). Appendix B Tables B-1, B-2, and B03 show a breakdown of job types for the alternatives.

Table 2

Number of Jobs and Officers in 1980 and 1990

Year	Number ^a of jobs	Inventory ^b (number of officers)	Year accessioned
1980	3,773	280	1973
1990	5,054	392	1983

^aBefore correction for number available for one year-group.

^bOne year-group.

Alternative SQ. This alternative is similar to current policy or "Status Quo." The criteria for success require that officers fulfill more obligations than are possible during the number of years available (12.5 to 15). In addition to attending the Command and General Staff College for 1 year, a senior service school (usually AWC) 1 year, and completing an advanced engineering degree in 2 years (4 years in VI), every officer should have (a) a troop assignment (II_B) during tours 1 to 3; (b) an engineering assignment such as construction management of facilities engineering (III) during tours 1 to 4; (c) a battalion command assignment (II_A) during tour 4 or 5; and (d) a cross-fertilization assignment (I) such as recruiting, teaching at the U.S. Military Academy (USMA), or serving in the non-accession specialty during tours 3 to 5. These four tours use approximately 12 years; these years plus the 4 years of schooling total 16 years. In addition, if the category I assignment is not in the non-accession specialty, a I_B tour should be counted as a fifth requirement, adding 3 years. Since completing all of these requirements is impossible, an interpretation of a "strict" requirement in this report means meeting three of the first four requirements; "liberal" means meeting only two of them; and schooling is not treated as a requirement.

Table B-1 summarizes the jobs available for the SQ alternative. This alternative differs from the actual status quo by assuming that xx21 engineers are available at the end of the sixth year and that the alternative also has no required attrition based on prior assignments.

Alternative SQ-WG. Although treated as a separate alternative, Status Quo With Gates (SQ-WG) is defined the same as alternative SQ except for the way in which attrition rates are applied. For the troop jobs that are considered absolutely necessary by present promotion board standards, the

attrition rate is set to zero by using the gate option. All attrition then comes from those officers who did not get the troop job (up-or-out)--a fairly good simulation of the actual situation. The jobs available are the same as those for alternative SQ (Table B-1). Except for assuming non-accession officers are available at the end of the sixth year, alternative SQ-WG simulates current OPMS policies.

Alternative TRK. The "tracked" alternative divides the engineers into different types at the beginning of the seventh commissioned year. The time simulated (7th through 21st years) is considered the development period during which officers complete training through assignments; their utilization phase will be during their years as a colonel (after simulated period). An officer is developed (tracked) as a Field Engineer, Engineering Concentrator, or TOPO Concentrator. A Field Engineer's jobs should be spread through categories I, II, and III; an Engineering Concentrator's jobs should be from categories II, III, and IV; a TOPO Concentrator should have jobs in categories II, III, and V with the major emphasis on V. For the Field Engineer, the largest group, a strict interpretation of meeting requirements is for each officer to have at least one assignment in each of the three allowed categories; the liberal interpretation requires only two of the three assignments. Strict and liberal are equivalent for the other two groups. The number of jobs available for alternative TRK is shown in Table B-2.

Alternative AWC. This alternative was recommended by the AWC group (Day et al., 1980). It also divides the officers into groups with one group of TOPO concentrators, defined as for the TRK alternative. However, the rest of the officers are originally in only one other group, and the development period is during tours 1 to 3 only (captains and majors). These officers should have each of their first three tours in any of the first four categories, and each should be different (strict interpretation). During the beginning of the utilization phase of their career (tours 4 and 5), officers must serve in any two of the categories previously assigned in tours 1 to 3, and the two tours must be different. The liberal interpretation (non-TOPO group) of requirements requires that, of the first three assignments, at least two must be different; if an officer is assigned to the THS account during one of the last two tours with the other tour matching a previous assignment, the requirement has been satisfied. A TOPO concentrator must have at least one TOPO tour in each set of tours (1 through 3; 4 and 5). Table B-3 shows the number of jobs for this alternative.

Comparison of Alternatives

CASTLE test results are given because a discussion of CASTLE output interpretation is indispensable to an understanding of the model's usefulness. However, the number of jobs of each type is not precise. In addition, there is no particular rationale for the number of officers assigned to each group. In actual use, the number of jobs would have to be exact and several trials of each alternative that has more than one officer type would have to be run. Each trial would have a different number of officers per group until the numbers that produced the best results were obtained. Therefore, the numbers and comparisons in this report should be considered only examples and no decisions should be based on them.

Based on different sets of random numbers, five replications of each alternative were performed to test the program. Results are shown for each replication. Table 3 summarizes the first set of results; complete data used for generating the summary data are in Appendix B, Tables B-4 through B-11.

Table 3

Percentages of Officers Meeting Requirements in Each Simulation

Alternative requirements met	Replication				
	1	2	3	4	5
SQ	(112)	(94)	(99)	(106)	(112)
None	57.1	47.9	47.5	54.7	60.7
Liberal	33.9	52.1	42.4	38.7	33.0
Strict	8.9	0	10.1	6.6	6.3
SQ-WG	(118)	(101)	(108)	(91)	(97)
None	60.2	51.5	52.8	36.3	47.4
Liberal	22.9	28.7	36.1	52.7	25.7
Strict	16.9	19.8	11.1	11.0	26.8
TRK	(112)	(94)	(114)	(112)	(87)
None	11.6	4.3	7.9	18.7	1.1
Liberal	58.9	63.8	69.3	53.6	71.3
Strict	29.5	32.0	22.8	27.7	27.6
AWC	(112)	(118)	(104)	(110)	(106)
None	13.4	19.5	29.8	24.5	25.5
Liberal	80.4	65.2	54.8	65.4	61.3
Strict	6.3	15.3	15.4	10.0	13.2

Note. Number in parentheses is total number of officers at end of five tours.

If the assumptions made during development of the TRK and AWC alternatives are realistic, the following conclusions can be generated from the tabular summary:

1. Many more officers fail to meet the requirements in either the SQ or SQ-WG alternatives (57.1% and 60.2% respectively) than in the TRK (11.6%) or AWC (13.4%) alternatives.
2. More officers meet the strict criteria in the SQ alternative when the "up-or-out" policy is more realistically simulated in the "with gates" SQ-WG option (16.9% versus 8.9%). However, note that the very strict interpretation of meeting all four criteria is not met by any officers in either the SQ or SQ-WG alternatives

(Tables B-4 through B-7, Appendix B). Table B-12, Appendix B shows the combinations of requirements met in the SQ alternative.

3. The TRK alternative seems preferable to AWC because a smaller percentage of officers met no criteria and a larger percentage met the strict criteria. The choice, however, may have to be made on the basis of acceptability to both management and the officer corps.
4. An unexpected but logical result shows in the data for all alternatives except AWC: the more officers who are left at the end of five tours, the larger the percentage of officers meeting no criteria and the smaller the percentage of officers meeting strict criteria--apparently a function of the utilization rate. When more officers compete for the same jobs, fewer are able to get the required assignments and are, instead, utilized in their non-accession specialty. The AWC alternative has not been investigated to determine why it does not seem to be affected in the same way; possible causes are the number of officers assigned to each group or the difference in success criteria.

Required Versus Filled Jobs. Examination of the raw data revealed that of the officers not restricted from serving in nonengineer jobs, many SC 21 officers were serving several tours in their non-accession specialty. These officers were the ones who did not meet even liberal requirements. It was realized that the 1990 inventory was the number of officers projected as required in the future. However, all of the above computations were performed using the current number of filled jobs. This number is much lower (about 40%) than the number of filled jobs would be if there were not an officer shortage (see Table 2). Therefore, an additional set of evaluations were made using the projected 1990 (required) number of jobs and the projected 1990 number of officers. For an example of the differences in number of jobs, compare Tables B-2 and B-15.

For Tables 4 and 5, liberal and strict are defined as before. However, two new categories have been added to both of the SQ alternatives to more fully show the effects of additional available jobs: (a) very strict for SQ is defined as meeting all four requirements; and (b) very liberal is defined as meeting only one requirement. Strict and very strict are equivalent for TRK and AWC, as are liberal and very liberal. Table 4 was developed from the same data (Tables B-4 through B-11) as column one of Table 3--1990 inventory and current 1980 jobs filled.

A much larger number of Engineer jobs was used for the results summarized in Table 5. These comparisons show that more specialty jobs for the same number of officers produce better within-specialty success rates. Statistical significance has not been computed because the beginning numbers of officers are different. Table 5 is based on fewer officers as well as on more jobs. Since both more jobs and fewer officers produce higher success rates, the differences between Table 4 and Table 5 are slightly inflated. However, the differences are so great that the greater number of jobs produces most of each difference.

Table 4

Percentages of Officers Meeting Requirements Using Current (1980)
Filled Jobs and Projected 1990 Inventory

Alternative	Requirements met				None
	Very strict	Strict	Liberal	Very liberal	
SQ	0	8.9	33.9	50.0	7.1
SQ-WG	0	16.9	22.9	41.5	18.6
TRK	29.5		58.9		11.6
AWC	6.3		80.4		13.4

Note. N = 400 officers, 3,773 jobs.

Table 5

Percentages of Officers Meeting Requirements Using Projected 1990
Jobs and Projected 1990 Inventory

Alternative	Requirements met				None
	Very strict	Strict	Liberal	Very liberal	
SQ-WG	10.0	31.8	33.6	12.7	11.8
TRK	64.4		35.6		0
AWC	63.1		21.4		15.5

Note. N = 392 officers, 5,054 jobs. SQ was not computed.

Utilization Rates. The data show that career success policies that do not specifically consider utilization rates may be ignoring an important make-or-break criterion. In all of the tested alternatives, more officers are serving in non-accession specialties than are meeting the SC 21 requirements.

Since all replications are equivalent except for randomness (discussed in a later section, Sensitivity Analysis), the first replication of each alternative was used to compute U with the 1990 inventory. Additional CASTLE runs were performed to provide data for the current inventory for three of the alternatives. These data are in Table B-13 and are summarized in Table 6.

Table 6

Utilization Rate--Current (1980) Jobs with 1980 and 1990
Officer Inventories

Alternative	1980 officer inventory	1990 officer inventory
SQ	73.2	51.4
TRK	71.0	52.8
AWC	73.8	49.6

Note. N = 3,773 current (1980) jobs, N for 1980 inventory = 280; N for 1990 inventory = 392.

Table 6 shows that an increase in the number of officers (as projected) would bring U down to within the expected U range. U was also computed for the projected 1990 jobs filled with the projected 1990 inventory. These data, summarized in Table 7, show that U would again be relatively high (complete data are in Table B-14). A slight increase in the ratio of specialty jobs to officers would again produce a U that is greater than the maximum MILPERCEN goal of 67%.

Table 7

Utilization Rate--Projected 1990 Jobs and Inventory

Alternative	Tour					Overall
	1	2	3	4	5	
SQ-WG	57.3	69.1	68.2	71.8	70.9	67.5
TRK	53.4	73.8	74.8	65.0	62.1	65.8
AWC	57.3	70.9	68.9	69.9	62.1	65.8

Note. N = 392 projected 1990 officers; N = 5,054 projected 1990 jobs.

Note that the U shown in Table 6 for current inventory and current jobs is less than the SC 21 rate discussed earlier (see Dual Specialties and Utilization Rates section). If CASTLE were correctly simulating the SQ alternative and the input data were correct, the SQ U should have been at least 80 and probably higher. An investigation revealed that the number of jobs input was too small; this error artificially deflated the U. This result then poses another problem that must be considered by MILPERCEN--the U for projected 1990 inventory and fill of 1990 projected jobs is also artificially

deflated by the same amount. Therefore, with the MILPERCEN projections, it would never be possible for the SC 21 U to be within the desired range.

SENSITIVITY ANALYSIS

Before using CASTLE to produce data for actual personnel management policy decisions, it seemed prudent to assure that changes to the input data produced logical output changes. A set of additional runs was made to test the sensitivity of the model to changes in each of the variables.

All sensitivity analyses, except for random attrition effects (shown in Table 9), were performed using the TRK alternative, 1990 inventory, and current filled jobs. This set of data was used throughout, changing only one variable at a time, to test the model's sensitivity to each change. The variables were of two types: (a) internal variables, created to satisfy the computer programming requirements; and (b) input data, based on present or projected data. All variables except random numbers were input parameters. Table 8 summarizes the variables and the related output data most sensitive to them. Data from this CASTLE run appear in Tables 9 through 13 as the control entry.

Table 8

Variables for Sensitivity Analysis

Internal variables	Relates to:
Random number	Number of officers in system after five tours
Potential (score)	Number or percentage filling each job type
Change in potentials	Percentage fill/job and/or career pattern change
Order of officer groups	Which optimum solution is found first
<u>Input Data</u>	
Attrition rate	Number of officers in system after five tours and percentage meeting requirements
Number of officers	Percentage meeting requirements and utilization rate
Number of jobs	Percentage meeting requirements and utilization rate

Table 9

Effects of Random Attrition on Number of Officers
Left at the End of Five Tours

Replication	SQ	SQ-WG	TRK	AWC
1	112	118	112	112
2	94	101	94	118
3	99	108	114	104
4	106	91	112	110
5	112	97	87	106

Note. SQ mean = 104.6; standard deviation = 7.99; expected range = 84.0 - 125.2.

Table 10

Effects of Change in Potential (CP) Variable on Number
of Officers Meeting Requirements

Change	Number meeting requirements/number officers			
	Group 1	Group 2	Group 3	Overall
Control	55/78	25/25	4/4	84/107
Change two relative CPs (+ small)	55/78	25/25	4/4	84/107
Change same two CPs (- small)	55/78	25/25	4/4	84/107
Small change--all CPs	65/78	25/25	4/4	94/107
Large change--all CPs	73/78	25/25	4/4	102/107

Table 11

Effects of Officer Group Order on Number of Officers
Meeting Requirements

Change	<u>Number meeting requirements/number officers</u>			
	Group 1	Group 2	Group 3	Overall
Control	55/78	25/25	4/4	84/107
Group 3 becomes Group 1 and Group 1 becomes Group 3	70/84	22/22	1/1	93/107

Table 12
Effects of Attrition Rate on Number of Officers Meeting Requirements

Change	Tour	Original attri- tion rate	Amount changed	Attrition rate used	Number meeting requirements/number officers		
					Group 1	Group 2	Group 3 Overall
Control		24	0	24	55/78	25/25	4/4 84/107
Small positive	1	24	+1	25	55/78	25/25	4/4 84/107
	5	33	+1	34	55/78	25/25	4/4 84/107
Small negative	1	24	-1	23	56/78	25/25	4/4 85/107
	5	33	-1	32	55/78	25/25	4/4 84/107
Large positive	1	24	+5	29	62/75	25/25	4/4 91/104
	5	33	+5	38	53/75	24/24	4/4 81/103
Large negative	1	24	-5	19	49/83	25/25	4/4 78/112
	5	33	-5	28	57/83	27/27	5/5 89/115

Table 13

Effects of Changing All Attrition Rates on Number of Officers
Meeting Requirements

Type change	Amount changed	1	2	3	Total
Control	0	55/78	25/25	4/4	84/107
Small/positive	+1	57/74	24/24	4/4	85/102
Large/positive	+5	56/56	17/17	4/4	77/77
Small/negative	-1	58/83	25/25	4/4	87/112
Large/negative	-5	60/120	29/29	5/5	94/154

Internal Variables

Internal variables should cause either no change in the output or a predictable change. The variables that do cause change should be used to fine-tune the model to the particular system to be simulated.

Random Number. Table 9 shows the number of officers for each alternative left in the system after five tours. Five replications of each were run to test effects of different random numbers. The mean and standard deviation from the first alternative was used to compute the expected range at the .99 level of confidence. The variations about the mean do not exceed random variation for any alternative, which is exactly what would be expected from the use of random numbers to determine the exact number of officers to attrit. Appendix B Tables B-4 through B-11, generated from these same data, also show the means and standard deviations. Although expected ranges are not shown for all of these, it can be observed that all values would be within the expected ranges.

Potentials. As long as high potentials were equal to each other and low potentials were equal, no changes in the beginning potentials produced changes from the control. Since career paths were identical when all potentials were changed a relative amount, a table of results was not prepared. Potentials were not reversed in relative size because this feature had previously been used to restrict officers from some job types, and the model had proved sensitive to relative size reversal. Additional runs should be made, setting each high potential to a different value, and, if appropriate, setting low potentials to varying low values to verify that the value weighting could be used.

Change in Potentials. This variable is used to reduce an officer's potential for an additional assignment to the same position. As shown in Table 10, small changes in two relative CP variables produced no change. Change to all CPs, however, began to change the career patterns. As both small and large changes to CP produced more officers meeting requirements in Group 1, many additional runs should be made, changing each CP in both

directions to determine whether a larger change would produce additional effects. If so, CP could be used with the potential parameter to tailor the system.

Officer Group Order. The change from control in Table 11 may be a function of the previously discussed system optimization by OTT--the first optimum solution is not changed. The change could also be a random effect, since the numbers are still within the random distribution range. Additional runs are necessary to determine which possibility is the cause. If the change is actually a function of OTT, the effect could be minimized by reversing the order in which the groups are assigned for each tour, including changing the position of Group 2.

Input Data

If models are to be used for policy change decisions, the models should be relatively sensitive to input variables. Small changes should not produce widely varying results, but significantly different data should produce significant differences. Additionally, the differences should be in the expected, or logically reasonable, directions.

Attrition Rate. Attrition rates were input as percentages converted to decimals. Changes used were plus and minus an additional 1% or 5%. Changes were made first to only one tour at a time. Table 12 shows the results of changes to Tour 1 and Tour 5.

Results are as would have been expected: 1% is a very small proportion of the original rates and produces negligible differences, 5% produces more differences in the expected directions. Not only are there fewer officers left when the attrition rate is higher, but the number of officers meeting requirements is higher when the attrition is higher in the first tour (fewer officers are left to compete for jobs during the remaining tours). The converse is true for the 5% negative change.

In Table 13 all attrition rates, expressed as percentages, were changed by 1% and 5%, both positively and negatively. Again, results are as would have been expected.

Number of Officers and Number of Jobs. Although these variables are input separately, the results are determined by the variables' ratios to each other. Tables 4 and 5 show the difference in percentage of officers meeting requirements when the ratio of jobs to offers is increased. Table 6 shows the changed utilization rate when the number of jobs is constant and the number of officers is increased. Changes in both meeting requirements and U rate are in the expected direction and of a reasonable order of magnitude. This result solidifies the demonstration that CASTLE is sensitive to input job and officer data.

DISCUSSION

CASTLE can be a useful tool for evaluating personnel management policies prior to implementation. As with any information aid, however, information

that has been generated from poor data and unrealistic assumptions, but which the planner treats with a high level of confidence, may be worse than no information. With no information, planners realize they are operating in an uncertain environment and may proceed more cautiously.

All CASTLE results should be studied and interpreted with caution. For example, inspection of Figure 6 might cause a decisionmaker to decide that the SQ-WG alternative is better than the SQ alternative because a larger percentage of officers are meeting a strict requirement (three of four). However, remembering that the definition of SQ-WG includes the assumption that officers who have not had battalion command will probably not be promoted to colonel, the decisionmaker should study Table B-12 more closely and compare it with Table 14, which shows the strict portion of the career pattern for SQ-WG. Table 14 reveals that the majority of officers who will be promoted will have met, at most, one requirement other than battalion command; the officers who met three of four requirements will not be promoted.

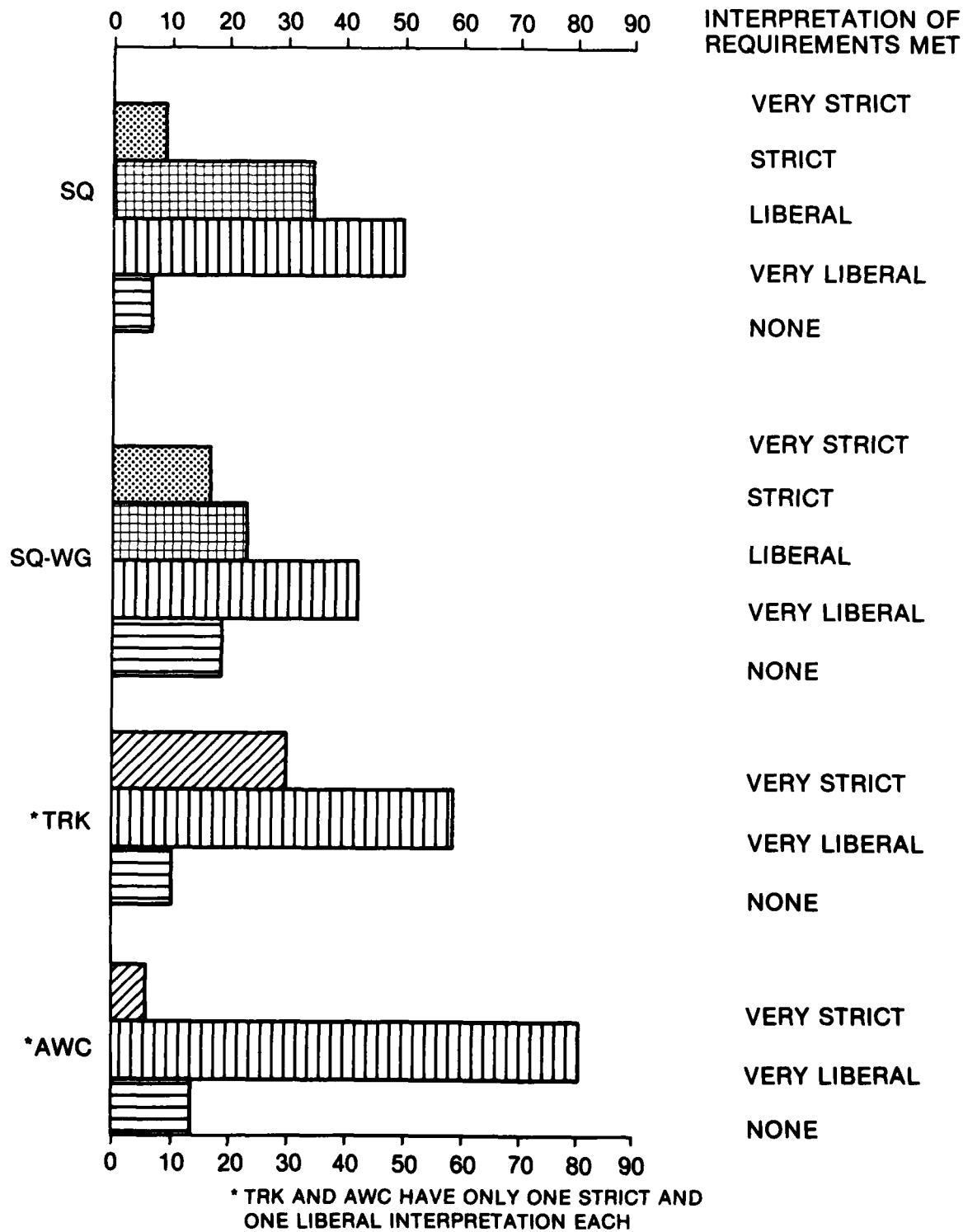
Table 14

Career Pattern of Officers Meeting Three of Four Requirements,
SQ Alternative, Inventory, Current Jobs

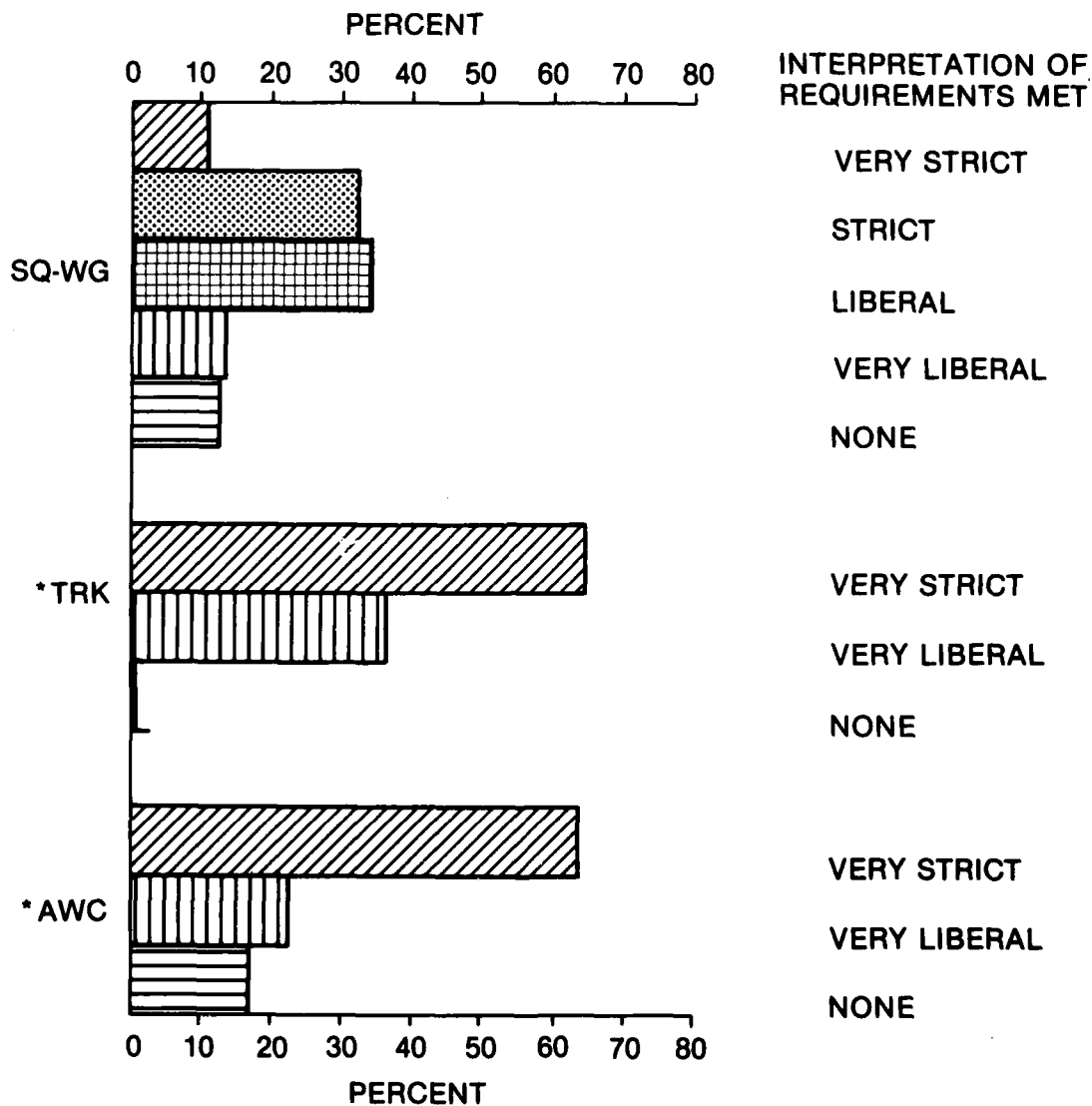
Troop duty	Tours/requirement			Number meeting requirement by replication				
	1-3/ Btn. cmd.	4-5/ Cross- fert.	3-5/ 1-4/ CM	1	2	3	4	5
X		X	X	17	20	7	2	21
X	X	X		3	0	4	0	5
	X	X	X	0	0	0	8	0

Since neither SQ nor SQ-SG looks desirable, the next step is to compare them with TRK and AWC; TRK looks more desirable in terms of percentage of officers meeting the strict interpretation. However, whether an officer qualified as TRK strict is actually better prepared for high-level jobs is a subjective or value judgment that can only be made by someone who thoroughly understands the SC 21 job requirements and the definitions of all alternatives and strict interpretations. An additional step is determining whether the officers will be promoted to a level in which their particular experience will be most useful.

Before making any decisions, it is necessary to determine whether all numbers used to create the data were correct. For example, Figure 7 was developed from CASTLE output created with almost the same input data as Figure 6. In Figure 7, however, the percentage of officers meeting strict requirements is approximately equal for both the TRK and AWC alternatives;



**FIGURE 6. PERCENT REQUIREMENTS MET
WITH CURRENT (1980) JOBS FILLED**



*TRK AND AWC HAVE ONLY ONE STRICT AND ONE LIBERAL INTERPRETATION EACH

FIGURE 7. PERCENT REQUIREMENTS MET WITH PROJECTED (1990) JOBS FILLED

TRK is still slightly better since more officers are meeting the liberal requirements and fewer are meeting none. The only difference in the input data was the number of jobs filled; when the projected 1990 jobs are filled more specialty jobs are available. If the 1990 projection is the correct number of jobs, the determination of the best alternative may have to be based on which definition of strictness will best satisfy the individual officers, the personnel managers, and the COE. But what if it is impossible to change the criteria that promotion boards actually use? It is, of course, easy to change the definition of "qualified" given to a board, but is there a means to insure that the board uses the new definition?

It is impossible to overemphasize the need for valid input data; the sensitivity analyses showed the differences caused by input data, and the comparison of Figures 6 and 7 also displayed the sensitivity. Because such assumptions as whether promotion criteria can be changed cannot be verified a priori, it is necessary to consider probabilities of occurrence. In addition, since it may not be possible to state precisely the number of people and jobs that may be available, alternatives should be compared using upper and lower limits and various combinations. The most desirable alternative is probably that which produces acceptable results across the entire range.

Better attrition data is an obvious need. Attrition rates may be different for various career paths or may change in response to changes in personnel policies. Sensitivity analyses showed the success rate is sensitive to the time period in which it occurs. If MILPERCEN could collect longitudinal data that showed whether attrition is related to specific assignments or to such combinations as tour type and years in service, these data would be valuable CASTLE input.

CASTLE output is difficult to use; much hand tabulating of numbers is necessary to produce percentages meeting requirements and utilization rates. Program enhancements could be added to provide additional summary routines. If this enhancement is done at a later date, it is also necessary to require the user to input officer type and job type labels. Summary outputs should tell which officers met which requirements, not just how many officers met three of four requirements, two of four, and so forth. Otherwise the user may not notice data such as that pointed out above: few officers who met as many as three requirements had the important job of battalion command.

A Comparison and Display Procedure

Before implementing a new policy, each assumption should be thoroughly checked, both in terms of how likely it is to be valid and of the differences in outcomes when it is valid and when it is not. Assuming the assumptions are independent, a suggested procedure is as follows:

1. Develop a matrix that lists at the left all possible combinations of alternatives, numbers of jobs and people, and other assumptions such as promotion criteria, non-accession specialty requirements, and officer availability (see Figure 8). The list on the left might also contain different numbers of specialty-specific jobs or other cross-fertilization jobs.

Quantity of officers and jobs	Alternative 1	Alternative 2	Alternative ...	Alternative n
PRESENT PROMOTION CRITERIA				
Min officers, min jobs				
Mod officers, mod jobs				
Max officers, max jobs				
No non-accession jobs:				
Min officers, min jobs				
Mod officers, mod jobs				
Max officers, max jobs	$p = .0028$	$p = .0028$	$p = .0028$	$p = .0028$ $f = 63.1, e = .1767$
Min officers, max jobs				
Mod officers, max jobs				
Max officers, min jobs				
Max officers, mod jobs				
CHANGED PROMOTION CRITERIA				
Min officers, min jobs				
Mod officers, mod jobs				
Max officers, max jobs				
No non-accession jobs:				
Min officers, min jobs				
Mod officers, mod jobs				
Max officers, max jobs	$p = .0012$	$p = .0012$	$p = .0012$	$p = .0012$ $f = 63.1, e = .0757$
Min officers, max jobs				
Mod officers, max jobs				
Mod officers, min jobs				
Max officers, min jobs				
Max officers, mod jobs				

Figure 8. Sample decision matrix.

2. Compute the probability of occurrence for each cell. The cell probability is a multiplicative function of the assumption probabilities. For example, if

p_1 = probability that SC 21 officers will not be required to fill non-accession jobs = .1,

p_2 = probability that all desired accession officers will be available = .5,

p_3 = probability that all desired non-accession officers will be available = .2,

p_4 = probability that all SC 21 required jobs can be filled = .4, and

p_5 = probability that promotion criteria can be changed = .3,

then the cell probability for the row "No non-accession jobs, maximum number of officers, maximum number of jobs, and changed promotion criteria" is

$$(p_1)(p_2)(p_3)(p_4)(p_5) = (.1)(.5)(.2)(.4)(.3) = .0012,$$

and the probability for the present promotion criteria row ($1.0 - .3 = .7$) with all other assumptions the same is

$$(.1)(.5)(.2)(.4)(.7) = .0028.$$

3. If any probability is zero, cross out the entire row; all cell probabilities will multiply to zero. The remaining cells in the matrix represent the number of different CASTLE runs that must be made to completely define the dimensions of the comparison problem.

4. Decide the criteria for which each alternative would be acceptable. If alternative n were AWC and the percentage of officers meeting only strict criteria is the acceptable criterion, the percent (using test data from Table 5) is 63.1.

5. Multiply the deciding factor and the cell probability to produce the expected value:

$$e_1 = (f)(p) = (63.1)(.0028) = .17668$$

$$e_2 = (f)(p) = (63.1)(.0012) = .07572$$

6. When the entire matrix is completed, compare the final e values. These should be more enlightening than comparisons of raw data or success rates. Very good success rates with low probabilities of occurrence are probably less desirable than are slightly lower success rates with a high probability of occurrence.

7. Show the probabilities of each assumption to the decisionmaker to gain concurrence. Then show the expected values of each of the alternatives, perhaps with several different probability values, for controversial assumptions. Decisions can then be made on objective data rather

than on subjective hunches about what is good for the specialty, for the officer, and for the Army.

Conclusions and Summary

New assignment policies are being created for the Engineer officer specialty (SC 21) with the goal of developing a sufficient number of qualified officers to meet the needs of the Engineer corps. CASTLE was developed specifically to provide longitudinal data to MILPERCEN SC 21 personnel managers for evaluating new policies prior to implementation. Since there are other specialties with similar problems, CASTLE was designed as a generalized model. CASTLE has demonstrated a capability to generate outcomes consistent with empirical data. Although the results do not represent a complete validation, they provide considerable credibility. Complete validity will be demonstrated by a longitudinal comparison of empirical data against CASTLE predicted results. MILPERCEN is presently using CASTLE to evaluate new SC 21 personnel management policies.

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PRECEDING PAGE

APPENDIX A

GLOSSARY

Terms derived from the Officer Personnel Management System are denoted by (OPMS); terms used for describing the model are denoted by (CASTLE).

accession specialty--See specialty; officer.

adjustment parameter--See input parameters.

algorithm--A prescribed set of well-defined roles or processes for the solution, usually in finite steps (CASTLE).

alternative--One of the four different policies evaluated and reported on in this report. (CASTLE)

assumptions--Conditions concerning policies which the user believes are or will be true. Values of input parameters are determined based on these conditions. (CASTLE)

attrition rate--The percentage of officers who leave the active Army in a 1-year time period (OPMS). Also see input parameters.

authorized jobs --See jobs, officer.

AWC--The Army War College, attended by lieutenant colonels and colonels (OPMS).. An alternative policy recommended by a study group of AWC students (CASTLE).

career, officer--The length of time an officer serves in the Army, usually thought of as at least 20 years (OPMS).

development phase--For OPMS accession specialties, the period of an officer's career when developmental schooling and assignments are restricted to the officer's accession specialty. Currently this period is considered years 1-8 after commissioning, before the non-accession specialty is designated. (OPMS)

utilization phase--The period during which an officer receives no additional specialty training or developmental assignments. During this phase officers use their prior experience to competently perform their job duties (OPMS).

change in potential--See input parameters.

CM--Construction management, a job in the Engineer specialty (CASTLE).

commission--Appointment as an officer of the U.S. Army. In the specialties managed by OPMS the officer is usually commissioned in the grade of second lieutenant. Medical, legal, and religious officers are not managed by OPMS and may be commissioned in a higher grade (OPMS).

company grade--See grades, officer.

CP--See input parameters, change in potential.

cycle--One set of assignments in CASTLE. Normally several sets of assignments (cycles) are produced from one CASTLE run (CASTLE).

deterministic--See process.

development phase--See career, officer.

field grade--See grades, officer.

filled jobs--See jobs, officer.

gate option--See input parameters.

grades, officer--Officer's rank. Each time an officer is promoted the rank or grade is increased one rank from second lieutenant through the general officer ranks. Officer grades are often grouped as company, field, senior, or high level to signify relative levels of responsibility (OPMS).

company grade--Second lieutenant, first lieutenant, or captain (OPMS).

field grade--major, lieutenant colonel, or colonel (OPMS).

high-level grades--colonel or general (OPMS). High level is also used to signify jobs that can be filled by officers with these ranks (CASTLE).

senior grades--Lieutenant colonel or colonel (OPMS). Also used to discuss jobs which can be filled by officers with these ranks (CASTLE).

groups, officer--See input parameters.

high-level grades--See grades, officer

input data--One of the types of CASTLE input parameters. The input data is created by the user based on historical data, projections of data such as numbers of officers accessioned, or assumptions (CASTLE).

input parameters--See also input data and internal variables.) All except random numbers are input to CASTLE. The set of all inputs are termed input parameters (CASTLE).

adjustment parameter--The total number of jobs of each type is input first. Then based on various assumptions an adjustment parameter is input for each job type for each tour. The adjustment parameter is based on other data such as number of year-groups competing for the jobs and alternative assumptions (CASTLE).

attrition rate--Since attrition rates (see above) are different for each year-group, for each year, for each specialty, and may be different for each job, CASTLE attrition input is separate for each job for each tour (CASTLE).

change in potential (CP)--After assignment to a job the officer's potential is decremented by the amount specified by CP. If CP is very small, the officer is likely to be assigned to it again; this is used to single-track officers. If the CP is very large, an officer probably will not be assigned a second time (CASTLE).

gate option--Used to specify whether there is an absolute requirement for a particular assignment. If there is, more attrition will be from the officers who did not receive the assignment (CASTLE).

groups, officer--Based on data input about officer types, CASTLE creates simulated data for groups of officers, one group for each type. The number of officers in each group is also input (CASTLE).

job types--Jobs in the engineer specialty which are considered similar because of the type of work (troop), because of education requirements (TOPO), or because the only requirement is that the officer be an accession engineer (category I in Tables B-1 through B-3) (CASTLE).

number of jobs--The number of Engineer specialty jobs to be filled. This report used both the number available in 1980 and those expected to be filled in 1990. Because there is now a shortage of officers, the number of 1980 jobs is smaller than the number of 1990 jobs. Number of jobs is input separately for each job type (CASTLE).

number of officers--The number of officers input as available for assignment; this number is decremented at the end of each assignment cycle by the number required by the attrition rate. The numbers used in this report are the number of officers presently available to the Engineer specialty for filling Engineer jobs (these officers were accessioned in 1973 and are beginning the seventh year; 1980 Inventory), and the number expected to be available in 1990 (CASTLE).

officer types--Officer types are defined by the alternative. They can be considered all one type, two types based on accession or non-accession, or several types based on other characteristics such as education. See groups, officers (CASTLE).

potentials, officer--Since the algorithm used for assigning officers required a "score" for each officer, the score was given a more general name--potential. This can be used to assign officers to a job because they have unique education or experience, because they need the job, or because they do not have the background for assignment to other jobs, i.e., it can be used to

signify the officer should be assigned to jobs for any reason defined by alternative assumptions. (CASTLE)

internal variables--All except the random numbers are input parameters. However, these can be considered artificial parameters that the user would not normally consider as required input, but as necessary to CASTLE to simulate the alternative being considered. For example, see input data; change in potentials, and potentials. (CASTLE)

iteration--One complete CASTLE run, usually several cycles (CASTLE). See also run.

jobs, officer--The total number of jobs to be filled. Depending upon the circumstance, job is qualified by one of the following adjectives: authorized, filled, or required (OPMS).

authorized jobs--The total number of jobs which should be filled to meet Army force requirements during nonmobilization periods. Currently there is an officer shortage and all authorized jobs are not filled. (OPMS)

current jobs--In this report used as a synonym for filled jobs (CASTLE).

filled jobs--The authorized jobs which actually have officers assigned to them (OPMS).

required jobs--The total number of jobs which would be required to meet Army force requirements during periods of full mobilization. Normally the number of required jobs is greater than the number of authorized jobs (OPMS).

job types--See input parameters.

model--Theoretical statement(s), often mathematical, about the relationships of a set of facts and/or concepts. From these relatively abstract theories, "if...then..." statements can be deduced (CASTLE).

non-accession specialty--See specialty, officer.

number of jobs--See input parameters.

number of officers--See input parameters.

Officer Personnel Management System (OPMS)--Army policy relating to the professional development and utilization of officers, as explained in Department of the Army Pamphlet 600-3 (OPMS).

officer types--See input parameters.

OPMS--See Officer Personnel Management System.

OTT--A computerized assignment algorithm developed by ARI (CASTLE).

potentials, officer--See input parameters.

probabilistic--See process.

process--A systematized method or technique (CASTLE).

deterministic (process, model, or simulation)--An Operations Research (OR) term meaning the results are dependent upon predetermined data, i.e., the CASTLE results are directly related to the input parameters; the input parameters are determined prior to making a CASTLE run (CASTLE).

probabilistic (process, model, or simulation)--An Operations Research (OR) term meaning the results are dependent upon the probability distribution of the input data. Although real problems are more likely to be probabilistic than deterministic, they are often approximated by deterministic methods for purposes of developing an OR solution (CASTLE).

stochastic (process, model, or simulation)--A stochastic number is also called a random number. In computerized probabilistic models, the probable value of a variable is based on a random number. In CASTLE, if the attrition rate is 20%, we know the probability that an officer will leave the Army is .2. Whether a particular officer is selected for attrition is based on a random number.

random number--A number which is selected from a set of numbers in a manner such that every number has an equal probability of occurrence (CASTLE).

required jobs--See jobs, officer.

requirements--The numbers of officers needed to fill Army jobs (OPMS). Definitions of alternatives state that officers must serve in certain jobs. The number or percentage who met these definitions "met the requirements" of the alternative definition (CASTLE).

run--A computer term which means the program was used. One run is one use which produces one set of results (CASTLE).

senior grades--See grades, officer.

simulation--The replication of the functioning of a system in such a way that the results of the replication resemble the original system for the purpose at hand (CASTLE).

single track (also called stovepipe)--Limiting an officer's assignments to one (or to a few) job types within a specialty (OPMS).

slack variable--An Operations Research term. In order to create equations to be solved from inequalities, a dummy variable is created. It "takes up the slack" by taking on the values required to find the system of equations solution. In CASTLE the number of officers serving in one job type, usually the non-accession jobs, is treated as the slack variable (CASTLE).

specialty, officer--A set of job types which are similar in terms of duties performed, required officer education, or both. Each set is given a unique name and code. OPMS is designed to manage and assign officers by their specialty. Currently there are almost 40 officer specialties (OPMS).

accession specialty--The first specialty in which an officer develops expertise. It is assigned at time of commissioning (entry to the Army as an officer). Some combat arms specialties are accession specialties only. (OPMS)

non-accession specialty--An additional specialty to which an officer is currently designated at the end of the eighth year. Some specialties are non-accession specialties only. Jobs in these specialties will be filled only by field grade officers (OPMS).

specialty qualification--To become competent in performing specialty jobs. Expected to be complete at the end of the development phase (OPMS).

SQ--One of the alternatives considered in this report. It is similar to the current policies (status quo), but it does not have a gate option assumption and assumes officers may be assigned to non-accession jobs at the end of the sixth year (CASTLE).

SQ-WG--One of the alternatives considered in this report. This alternative is similar to the current OPMS policies (the Status Quo), and uses the gate option to attrit officers who did not get a battalion command (with gates). It differs from current policy by the assumption that officers may be assigned to non-accession jobs at the end of the sixth year (CASTLE).

stochastic--See process.

stovepipe--See single track.

TOPO--An Engineer specialty job, Topological Engineering (CASTLE).

transportation problem--A common type of Operations Research problem. In general terms, it is allocating resources from several sources among several destinations. Whether the objective function is to be minimized or maximized depends on the specific problem. In CASTLE the sources are the officer groups, the destinations, and the job types (CASTLE).

TRK--One of the alternatives considered in this report. In this alternative officers are tracked (see single-track) in one of several ways.

U--See utilization rate.

utilization phase--See career, officer.

utilization rate (U)--This rate is computed by dividing the number of specialty jobs by the number of specialty officers assigned to specialty positions. The MILPERCEN goal is that the average across all

specialties will be .5 and no specialty will have a U of less than .33 or greater than .67 (OPMS).

variable--An entity (event, object, or relationship) which assumes values in a prospecified manner (CASTLE).

year-group--A group of officers composed of all officers who were commissioned in a given year and remain in the active Army (OPMS).

APPENDIX B

COMPLETE DATA TABLES USED FOR SUMMARY TABLES IN COMPARISON OF FOUR ALTERNATIVES

Table B-1

Current (1980) Jobs Available for Alternatives SQ and SQ-WG

Category	Tour					Career total available
	1	2	3	4	5	
I _A	165	171	102	121	133	692
I _B	---varies according to requirements---					
I _C	39	39	20	12	4	114
II _A				60	60	120
II _B	371	387	296	160	68	1,282
III	199	209	117	137	147	809
V	35	37	12	12	10	106
VI	226	220	96	72	35	649
Total	1,035	1,063	643	574	457	3,772

Table B-2

Current (1980) Jobs Available for Alternative TRK

Category	Tour					Career total available
	1	2	3	4	5	
I _A	165	171	102	121	133	692
I _B	---varies according to requirements---					
I _C	39	39	20	12	4	114
II	372	387	296	220	128	1,403
III	46	48	49	69	86	298
IV	153	161	68	68	61	511
V	35	37	12	12	10	106
VI	226	220	96	72	35	649
Total	1,036	1,063	643	574	457	3,773

Table B-3

Current (1980) Jobs Available for Alternative AWC

Category	Tour					Career total available
	1	2	3	4	5	
I _A	165	171	102	121	133	692
I _B	---varies according to requirements---					
I _C	39	39	20	12	4	114
II	372	387	296	220	128	1,403
III	21	22	28	42	53	166
IV	178	187	89	96	94	644
V	35	37	12	12	10	106
VI	226	220	96	72	35	649
Total	1,036	1,063	643	575	457	3,774

Table B-4

Alternative SQ--Number of Officers Meeting Requirements

Number of requirements met	Replication					X	S.D.
	1	2	3	4	5		
0	8	5	7	11	9	8.0	2.24
1	56	40	40	47	59	48.4	8.85
2	38	49	42	41	37	41.4	4.72
3	10	0	10	7	7	6.8	4.09
4	0	0	0	0	0	0	0
Number met requirements (strict and liberal)	48	49	52	48	44	48.2	2.86
Number did not meet requirements	64	45	47	58	68	56.4	10.16
Total	112	94	99	106	112	104.6	7.99

Table B-5

Alternative SQ--Percentage of Officers Meeting Requirements

Number of requirements met	Replication				
	1	2	3	4	5
0	7.1	5.3	7.1	10.4	8.0
1	50.0	42.6	40.4	44.3	52.7
2	33.9	52.1	42.4	38.7	33.0
3	8.9	0	10.1	6.6	6.3
4	0	0	0	0	0
Percentage met requirements (strict and liberal)	42.9	52.1	52.5	45.3	39.3
Percentage did not meet requirements	57.1	47.9	47.5	54.7	60.7
<u>N</u>	112	94	99	106	112

Table B-6

Alternative SQ-WG--Number of Officers Meeting Requirements

Number of requirements met	Replication					X	S.D.
	1	2	3	4	5		
0	22	11	18	13	12	15.2	4.66
1	49	41	39	20	34	36.6	10.74
2	27	29	39	48	25	33.6	9.69
3	20	20	12	10	26	17.6	6.54
	0	0	0	0	0	0	0
Number met requirements (strict and liberal)	47	49	51	58	51	51.2	4.15
Number did not meet requirements	71	52	57	33	46	51.8	13.99
Total	118	101	108	91	97	103.0	10.42

Table B-7

Alternative SQ-WG--Percentage of Officers Meeting Requirements

Number of requirements met	Replication				
	1	2	3	4	5
0	18.6	10.9	16.7	14.3	12.4
1	41.5	40.6	36.1	22.0	35.1
2	22.9	28.7	36.1	52.7	25.7
3	16.9	19.8	11.1	11.0	26.8
4	0	0	0	0	0
Percentage met requirements (strict and liberal)	39.8	48.5	47.2	63.7	52.6
Percentage did not meet requirements	60.2	51.5	52.8	36.3	47.4
<u>N</u>	118	101	108	91	97

Table B-8

Alternative TRK--Number of Officers Meeting Requirements

Group criteria	Replication					X	S.D.
	1	2	3	4	5		
1. No requirements	13	4	9	21	1	9.6	7.86
Liberal requirements	66	60	79	60	62	65.4	7.99
Strict requirements	0	4	0	3	2	1.8	1.79
2. No requirements	0	0	0	0	0	0	0
Strict requirements	31	23	22	24	18	23.6	4.72
3. No requirements	0	0	0	0	0	0	0
Strict requirements	2	3	4	4	4	3.0	1.73
Number met requirements (strict and liberal)	99	90	105	91	86	94.2	7.66
Number did not meet requirements	13	4	9	21	1	9.6	7.86
Total	112	94	114	112	87	103.8	12.42

Table B-9

Alternative TRK--Percentage of Officers Meeting Requirements

Group criteria	Replication				
	1	2	3	4	5
1. No requirements	11.6	4.3	7.9	18.8	1.1
Liberal requirements	58.9	63.8	69.3	53.6	71.3
Strict requirements	0	4.3	0	2.7	2.3
2. No requirements	0	0	0	0	0
Strict requirements	27.7	24.5	19.3	21.4	20.7
3. No requirements	0	0	0	0	0
Strict requirements	1.8	3.2	3.5	3.6	4.6
Percentage met requirements (strict and liberal)	88.4	95.7	92.1	81.3	98.9
Percentage did not meet requirements	11.6	4.3	7.9	18.7	1.1
<u>N</u>	112	94	114	112	87

Table B-10

Alternative AWC--Number of Officers Meeting Requirements

Group criteria	Replication					X	S.D.
	1	2	3	4	5		
1. No requirements	15	23	31	27	27	24.6	6.07
Liberal requirements	89	76	55	71	63	70.8	12.93
Strict requirements	6	16	15	8	12	11.4	4.34
2. No requirements	0	0	0	0	0	0	0
Liberal requirements	1	1	2	1	2	1.4	.55
Strict requirements	1	2	1	3	2	1.8	.84
Number met requirements (strict and liberal)	97	95	73	83	79	85.4	10.33
Number did not meet requirements	15	23	31	27	27	24.6	6.07
Total	112	118	104	110	106	110.0	5.48

Table B-11

Alternative AWC--Percentage of Officers Meeting Requirements

Group criteria	Replication				
	1	2	3	4	5
1. No requirements	13.4	19.5	29.8	24.5	25.5
Liberal requirements	79.5	64.4	52.9	64.5	59.4
Strict requirements	5.4	13.6	14.4	7.3	11.3
2. No requirements	0	0	0	0	0
Liberal requirements	.9	.8	1.9	.9	1.9
Strict requirements	.9	1.7	1.0	2.7	1.9
Percentage met requirements (strict and liberal)	86.6	80.5	70.2	75.5	74.5
Percentage did not meet requirements	13.4	19.5	29.8	24.5	25.5
<u>N</u>	112	118	104	110	106

Table B-12

Career Pattern--Alternative SQ, 1990 Inventory, Current Jobs

Number of requirements met	Tours/requirement				Number meeting requirement by replication						S.D.
	1-3/ Troop duty	4-5/ Btn. cmd.	3-5/ Cross- fert.	1-4/ CM	1	2	3	4	5	X	
0					8	5	7	11	9	8.0	2.24
1	X				27	21	20	21	23	22.4	2.79
1		X			5	4	1	8	7	5.0	2.74
1			X		14	11	18	10	13	13.2	
1				X	10	4	1	8	16	7.8	5.76
2	X	X			0	1	1	0	0	.4	.55
2	X		X		13	15	9	10	10	11.4	2.51
2	X			X	11	22	19	24	19	19.0	4.95
2		X	X		1	0	0	0	6	1.4	2.61
2		X		X	10	7	11	7	2	7.4	3.51
2			X	X	3	4	2	0	0	1.8	1.79
3	X	X	X		0	0	0	0	0	0	
3	X	X		X	0	0	0	0	0	0	
3	X		X	X	10	0	7	7	7	6.2	3.70
3		X	X	X	0	0	0	0	0	0	
4	X	X	X	X	0	0	0	0	0	0	

Table B-13

Utilization Rate--Current Inventory/Current Jobs

Alternative	Tour					Overall
	1	2	3	4	5	
SQ	50.6	64.9	80.5	85.7	84.4	73.2
SQ-WG						
			-----Not computed-----			
TRK all groups						
(Group 1)	44.9	71.0	79.7	81.2	78.3	71.0
(Group 2)	(28.3)	(62.3)	(73.6)	(75.5)	(71.7)	(62.3)
(Group 3)	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)
	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)
AWC both groups						
(Group 1)	48.6	68.9	83.8	89.2	78.4	73.8
(Group 2)	(44.9)	(66.7)	(82.6)	(88.4)	(76.8)	(71.9)
	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)

Table B-14

Utilization Rate--1990 Inventory/Current Jobs

Alternative	Tour					Overall
	1	2	3	4	5	
SQ	39.3	44.6	54.5	59.8	58.9	51.4
SQ-WG	40.7	44.1	54.2	58.5	58.5	51.2
TRK all groups	37.5	49.1	58.0	65.2	52.7	52.8
(Group 1)	(11.4)	(27.8)	(40.5)	(50.6)	(23.2)	(33.2)
(Group 2)	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)
(Group 3)	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)
AMC both groups	40.2	44.6	50.9	65.2	47.3	49.6
(Group 1)	(39.1)	(43.6)	(50.0)	(64.5)	(46.4)	(48.7)
(Group 2)	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)

Table B-15

Projected 1990 Jobs Available for Alternative TRK

Category	Tour					Career total available
	1	2	3	4	5	
I _A	165	171	102	121	133	692
I _B	--varies according to requirement--					
I _C	39	39	20	12	6	116
II _A	625	652	365	260	159	2,061
II _B	200	209	100	114	128	751
III	192	200	80	75	66	613
V	55	57	22	21	17	172
VI	226	220	96	72	35	649
Total	1,502	1,548	785	675	544	5,054