Strength management concerns matching the inventory of people in a military service with the needs for them in units and organizations that accomplish military missions. This chapter describes how the Army manages its strength and uses models to do so. The other Services use a similar generic process, but important specifics could differ by Service.1

**SPACES**

Where does the need for people come from? In general, the Defense Planning Guidance tells the Army what missions and scenarios to organize and train for. Internal Army processes lead to decisions about specific types of units to create, whether those units should be reserve or active, and whether those units should be resourced fully or at some lower level. Other processes determine the officer-to-enlisted mix and the grade and skill content for a type of unit.

The result of these force decisions is the Army’s programmed force structure, which is the set of units and organizations that exists in the current year and that is planned in each future year. The programmed manpower structure is the sum of all the requirements for military people by grade and skill in all units and organizations of the

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1 For example, at the aggregate level of managing strength the Army uses monthly forecasts as an important dimension. The Air Force includes grades at the aggregate level but only forecasts on an annual basis.
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Army programmed force structure. More commonly, this is referred to as the requirements. However, budget constraints or policy dictates may limit resourcing of these requirements with budgeted manpower. As a result, a force structure allowance is used to define billets in the programmed manpower structure that are planned to be filled in a given time period. These authorizations or “spaces” are what strength managers are most concerned with meeting as they deal with personnel management issues.

FACES

How many people by grade and skill are available to fill the spaces? The Army and the Department of Defense request an annual end strength, and the Congress approves (or adjusts it) during the budget process. This end strength needs to be large enough to provide operating strength or “faces” against authorizations in the units and organizations as well as to provide for people to be in training or in transition between assignments (“individuals”). The level of end strength budgeted and appropriated and how well the Army manages the individuals account and activities such as recruiting, training, and rotation can affect the number of “faces” that can be allocated to the “spaces.”

OPERATING STRENGTH DEVIATION

The difference between the number of people available to fill authorizations (operating strength) and the number of authorizations is called the operating strength deviation (OSD). If there are more

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2This includes TOE (Table of Organization and Equipment) units and TDA (Table of Distribution and Allowances) units.

3DoD policy is that at least 90 percent of requirements will be authorized for fill. Because of past problems in meeting this policy, the National Defense Authorization Act for FY 1996 requires the Secretary of the Army (beginning in 1999) to ensure that officer strength is sufficient to enable the Army to meet at least that percentage of the programmed manpower structure for officers that is provided for in the most recent defense planning. The Secretary of Defense is directed to provide to the Army sufficient personnel and financial resources to meet the requirement.

4The TTHS (Trainees, Transients, Holdees, and Students), or “individuals account,” is defined as the actual or projected people not filling billets in the programmed manpower structure.
people available than authorizations, the deviation is positive; negative deviation means more spaces than faces. The Army measures operating strength deviation throughout the operating year and as projected into a future year as it represents the capability to provide people to commanders of units who have been led to expect them by virtue of their authorizations. The deviation might be structural (either too many authorizations or not enough operating strength) or frictional (seasonal patterns of personnel entry, loss, and assignments cause differences). Moreover, if authorizations and strength are increasing or decreasing over the year, the balancing of faces and spaces is more difficult. Of course, whether the deviation is positive or negative at any point is influenced by anything that might affect either side of the equation. For example, an overly large force structure, programmed manpower structure, or force structure allowance could lead to a negative deviation, as could insufficient end strength or an overly large individuals account.

Strength managers are usually not responsible for the number of authorizations (although they may forecast future levels) or for the end strength or size of the individuals account (although they may predict future values for the latter given budget estimates of the former). Strength managers are responsible for determining the likely effect of recruiting, promoting, and separating activities on the ability to match faces to spaces, now and in the future. Thus, the objective in managing strength is to minimize the operating strength deviation in the Army, primarily in the enlisted force.5

**STRENGTH MANAGEMENT IS MODELED BECAUSE OF COMPLEXITY**

Strength managers might choose to match current and projected personnel inventory to authorizations in the aggregate, where the focus is on people moving in and out of the Army over time. The following equation reflects this focus:

\[
\text{FutureStrength} = \text{CurrentStrength} + \text{Gains} - \text{Losses}
\]

5Officer and warrant officer faces and spaces matter as well. However, the models of interest here deal with the enlisted force and only incorporate officer data to produce comprehensive reports.
The faces and spaces might be also matched on a disaggregate basis, where the match is by skill and grade and the focus is on movement within the Army. A disaggregate equation would be given as

\[
\text{FutureTrainedStrength} = \text{CurrentTrainedStrength} + \text{MOSgains} - \text{MOSlosses} + \text{Gradegains} - \text{Gradelosses}
\]

All in all, strength management is a complex process with equally complex interactions that benefits from the use of projection models that represent the strength management process. The primary tool of the strength manager is the inventory projection model (IPM), which implements the strength management algorithm with mathematical precision. IPMs come in two varieties, aggregate and disaggregate, corresponding to the two classes of strength management discussed above.

A simple aggregate model might have two dimensions: year of service and term of enlistment (first-term versus career). This is a low-granularity or level-of-detail model; higher-granularity models would have more inventory dimensions, such as grade or a division of the first-term population by accession characteristics (e.g., high/low quality), or the time periods could be in months rather than years. A disaggregate model is very granular (e.g., 300 MOSs). Every increase in granularity adds to model complexity, run time, memory requirements, input detail, and volume of output. For example, in the Army, projections are made over an 84-month time horizon, for some 300 skills, in 9 grades, using 12 personnel quality groups, differentiating male and female, and incorporating policy for recruiting, reclassifying, promoting, and separating. All of these dimensions must be continuously integrated into the future to answer significant questions about readiness and budget.

The first iteration of a model proceeds from the beginning populations (Year 1) to the first projected period (Year 2). Year 2 is entirely determined by Year 1, the rates, and a target strength for Year 2. The process is reiterated, using the same or modified rates, for each additional time period covered by the model. Mathematically, IPMs are Markovian chains. The precise Army architecture that implements the inventory projection model will be described in Chapter Four.
For example, gains can become an input, with projected strengths as an output. The Army models can incorporate such variations.

Aggregate models dominate disaggregate models. Because of small cell sizes and other complications, disaggregate models, when summed across all MOSs, produce a less accurate projection of the force than aggregate models. Therefore, many disaggregate models are designed so that the sum of disaggregate strengths and flows can be constrained to the strengths and flows projected by an aggregate model. For example, as will be shown in Chapter Four, ELIM uses historical data to develop aggregate gain and loss projections by month over seven years. These projections become a constraint for MOSLS, which projects how many soldiers will be in each MOS at each grade level in future time periods. The Army thus uses both an aggregate and a disaggregate model. Besides choosing to use an aggregate or disaggregate model, other modeling choices must also be made.

**STRENGTH MANAGERS HAVE MODELING CHOICES**

Other variations of inventory projection models are possible. Some of the more important distinctions follow:

- **Dynamic versus steady-state:** So far, we have discussed only dynamic IPMs—those that project from one time period to the next. A steady-state model generates the inventory distribution that would result if rates and flows were identical year after year. ELIM and MOSLS are dynamic models.

- **Group versus entity:** So far, we have discussed only group models. Group means that like individuals within the inventories are grouped into cells defined by the dimensions of the model. In an entity model, each individual is separately represented. ELIM and MOSLS are not entity models.

- **Deterministic versus stochastic:** We have been discussing deterministic models (the same inputs produce the same result for every model run). It is possible (and necessary, in the case of entity models) to make the models stochastic, allowing random distributions of outcomes to occur. ELIM and MOSLS are deterministic.
• **Officer versus enlisted:** Because of differences in officer and enlisted personnel management rules, models are almost always specific to either the officer or the enlisted force. ELIM and MOSLS represent the enlisted force.\(^7\)

• **Planning versus programming:** Planning models trade off precision (accuracy, granularity, and input detail) for speed. With a planning model, an action officer might examine a dozen alternative scenarios in an afternoon, working on a PC. A programming model, because of the need for more accuracy, may take a week to set up and all day to run on a mainframe or a work station. ELIM and MOSLS are programming models; ELIM has some limited planning use.

• **Short-term versus long-term:** A short-term model might project monthly from the current month to the end of the current fiscal year (requiring, incidentally, some seasonality of rates). A long-term model would project annually, from the end of one fiscal year to the end of future fiscal years using annualized rates. ELIM and MOSLS have short- and long-term capabilities.

• **Historic versus econometrically adjusted:** The underlying loss model in an IPM is almost always based on rates developed by observing losses in some historic period. In historically adjusted models, these rates are either used “as projected” or are subject to artful manipulation by analysts. In econometrically adjusted models, the rates are either determined or adjusted using forecasts of factors such as unemployment rates or military/civilian wage differences. Coefficients for these factors are developed by regressing historic loss rates on historic series of the factors. ELIM and MOSLS are historically adjusted.

Finally, analysts can choose which operations research techniques to use within the model. Simulation is useful for making predictions. In the short term, an analyst predicts the levels of certain “response” variables, such as strength, assuming that other “control” variables cannot be changed in the short term. For example, the number of new accessions into the training base for the next three months can-

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\(^7\)For reporting purposes, ELIM results include officer data. Officer strengths are not optimized within ELIM.
not be easily changed, nor can the number of expected losses from the existing force. In the long term, the analyst can set levels for certain control variables such as targeted strength, and then simulate to predict the impact of future behaviors such as retention.

Optimization can be used to answer policy and programming questions. For example, given the loss forecasts, how many new entrants and of which types need to be recruited in certain time periods? The goal is to get the “best” set of policies for accessing, training, promoting, reclassifying, and separating, assuming various constraints on the personnel management system (e.g., the size of the training base or the dollars available to promote people). “Best” is measured against some objective. A typical objective is to minimize the deviation of actual projected strength from targeted authorizations, that is, to minimize the operating strength deviation. The objective function might weigh these deviations by grade, skill, or time period to reflect decisionmaker preferences for penalties.

In this respect, ELIM and MOSLS are somewhat unusual in that they both simulate and optimize. We will examine this characteristic in detail in the next section.

MODELS ARE PART OF A PROCESS

Models do not operate in isolation from the management activities they support. ELIM and MOSLS give personnel managers coherent data for decisionmaking because the outputs of all the separate personnel management activities have been integrated. The two models provide a framework for personnel managers to think about changes in personnel policy that might lead to a lower operating strength deviation. Several generations of Army personnel managers have been imbued with the logic of ELIM and MOSLS, and Army people tend to think through both problems and opportunities in this common framework. Moreover, the models integrate accession, retention, training, promotion, and reclassification policies and organizations by providing an integrated framework for addressing near-term programming adjustments and long-term policy guidance. At least monthly, personnel managers with oversight for the several personnel management activities meet to discuss modeling issues, including policy inputs, policy prescriptions, and projected or predicted model results.
This chapter has reviewed Army strength management, the choices faced in modeling strength management, and the roles that ELIM and MOSLS play. The next chapter discusses how the two models actually work.