This appendix describes the model the Army uses to provide the details of military occupational specialty (MOS) and grade to Army enlisted personnel management.

**BACKGROUND**

Military Occupational Specialty Level System (MOSLS) is the model used by ODCSPER and PERSCOM to balance the MOS and grade-level requirements of the Army with the available population. It complements ELIM in that it provides grade and MOS detail, which ELIM does not consider.

MOSLS supports enlisted personnel policy at two levels. At the most aggregate level, MOSLS enables Army analysts to explore the implications of policies and behaviors that affect the Service’s need for total numbers of individuals of certain skills and grades. MOSLS also supports the analysis of voluntary loss behavior and of involuntary loss policies upon the entire enlisted force. At the more detailed MOS and grade level, MOSLS results can be used to assess the effects of promotion, reenlistment, and accession policies. In addition, MOSLS forecasts the Service’s need for newly trained individuals by skill and helps determine the training programs necessary to produce such individuals.

MOSLS is one system within the Army strength management family of models, resources, and products. Figure B.1 shows how MOSLS interacts with ELIM, other models, and data systems.
GENERAL ANALYTIC APPROACH AND ARCHITECTURE

Like ELIM, MOSLS uses both optimization and simulation to consider the ways the personnel community can control the enlisted force, the constraints upon various management options, and events beyond the control of the Service. The optimization function prescribes the best set of personnel management actions for what the Army can control, such as promotion, reclassification, and forced losses. The optimization models consider legal, resource, and budget constraints when determining the best sets of policies.

Simulation models are used to predict the behavior of the force beyond the Army’s control. Simulation provides a more accurate representation of the future force by replicating probable loss, aging patterns, and training graduation rates, which management policies cannot directly alter.

This appendix discusses the three primary elements of MOSLS: the pre-processor module and its inputs, the trained strength model, and the post-processor module. Figure B.2 provides a schematic of the

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**Figure B.1—Relation of MOSLS to Other Models and Databases**
architecture and how its components relate to each other. In general, the pre-processor determines the targets to which the model should optimize and the constraints that limit the optimization. It also includes the training simulation model, which projects how many individuals will be graduating from each skill training course. The trained strength model is a large network model that uses the trained output of the training simulation model and the targets and constraints of the pre-processor to model the most optimal force achievable. The post-processor includes the training requirements model, which considers the optimal force output from the trained strength model and reconsiders how the training simulation model should have allocated individuals across the skill training course. The post-processor also compiles the various output reports from MOSLS. The key outputs of MOSLS are the Enlisted Force Distribution and the Program Objective Force.

As Figure B.2 indicates, MOSLS contains three models: the training simulation model, the trained strength model, and the training requirements model. The interaction of the three models is central to the optimization process. The training simulation model begins the process by making a first estimate of the output from the MOS training pipelines over the 84 months of inventory projection. It considers what is current in each pipeline (and therefore cannot be changed) and estimates future pipeline production. This estimate is a “first guess” because the training simulation model does not have an accurate picture of promotions and losses over the 84-month projection.

The second model, the trained strength model, completes that picture. It takes the forecasts of the training simulation model and combines them with promotions, reclassifications, and losses to produce a detailed (grade, MOS, YOS) inventory projection. The model attempts to minimize the differences between the MOS requirements and inventory, adjusting promotions and reclassifications to do so.

When the projection is completed, the trained strength model looks at the MOS differences. If some difference are too large, the model adjusts training pipeline production, promotion, reclassification and forced loss rates, repeats the projection, reexamines MOS differ-
ences, makes adjustments, and repeats the projection. This iterative process continues until MOS differences do not improve iteration to iteration.

The third model, the training requirements model, takes the results of the trained strength model (specifically, the adjusted MOS training pipeline production) and determines what input is necessary to the MOS training pipelines to meet the detailed force structure requirements. The training simulation model and the training requirements model differ in the following way. On the one hand, the training simulation model takes annual accessions and makes an initial attempt at allocating those accessions to the various MOS training pipelines. The training requirements model, on the other hand, works backward. Given the results of the trained strength model, it determines what the accession allocation to the MOS training pipelines must be to meet the force structure requirements, effectively adjusting the initial attempt at allocation of the training simulation model.

The Pre-Processor

Inputs. The pre-processor accepts inputs in the form of data, rates, and policies; it provides targets and constraints for the next element of MOSLS. MOSLS accepts data input from several sources. The Enlisted Master File extract provides detailed information about the current enlisted force. The Gain/Loss File extract is an account of the actual gains and losses from the enlisted service updated on a
monthly basis. These two files provide input for MOSLS. They also are both used to compute loss and accession rates for the ELIM model. The output from the ELIM model is used to normalize the MOSLS total losses by category. The categories are ETS, retirement, and other.

Force structure and authorization data inputs, available in the PAM, provide the total number of units and the type and number of personnel authorizations by grade and MOS. Total strength and accessions data output from ELIM are also input to the MOSLS pre-processor. In addition, the Army Training Requirements and Resources System (ATRRS) provides detailed data about training schedule, the length of each class, the probable attrition or graduate rates, and the personnel currently in the skill training pipeline.

Policies that are user input to the pre-processor include relative priorities placed upon certain MOS, information about changing requirements for MOS, and forced loss or other programs that would affect the retention behavior of the force. Other personnel policies, such as planned reclassifications and forced loss programs are also inputs.

The policies input to the pre-processor are used in conjunction with the data inputs to determine the target, or optimal, force by grade and MOS that the model should strive to create. Thus, the target force, or trained strength targets, reflect policies such as priorities on certain MOS as well as authorizations for spaces, the numbers and types of soldiers in the individuals account,¹ and soldiers in space-imbalanced MOS.²

¹The individuals account generally includes TTHS, or trainees, transients, holdees, and students. It represents everyone who is not assigned to a unit, including prisoners and hospitalized individuals. Because MOSLS does include skill training, however, it accounts for individuals in the training pipeline, and these calculations to add the individuals account add only the additional TTHS. The size of the future individuals account is given in the ELIM interface file. MOSLS receives counts of the aggregate TTHS, which are broken down by grade counts using three years of historical data. The by-grade TTHS counts are used to modify the data to create the API (Authorizations Plus Individuals) targets used by the model.

²When MOS are designated solely for overseas duty, such as 4GR (Radio Broadcast Journalist), CONUS billets are designed to provide a rotation billet. These space-imbalanced MOS billets are added to the MOSLS target force in the pre-processor.
These inputs are manipulated to constrain the future system. Such constraints include short-term promotion bounds; any legislative restrictions, such as the legal limits on the number of E9s allowed; and budget constraints.

MOSLS has over 300,000 rates, based mostly upon MOS, grade, and YOS, which are input to the model. These rates will constrain the movement across the large network model in MOSLS that optimizes the future force. This will be discussed in more detail later. Table B.1 provides an example of many types of MOSLS rates and the basis by which they are applied. For example, the loss rates used for the trained strength force between grades E3 and E6 are applied to individuals by MOS, grade, YOS (within six months), years to ETS (within six months), and type of loss (e.g., mandated separations, directed separations, voluntary separations, death, etc.). These rates are managed by a database subsystem.

MOSLS rates are calculated based on a weighted average of the past 36 months. The more recent data is weighted more heavily. ELIM uses a different process, which employs exponential smoothing of up to 48 months of detail. Thus, the ELIM and the MOSLS rates are different, but a normalization process brings the final result of the calculations within MOSLS in line with those calculated by ELIM using

<table>
<thead>
<tr>
<th>Rates</th>
<th>Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trained strength loss (E3-E6)</td>
<td>MOS, Grade, 1/2 YOS, 1/2 YETS, Type</td>
</tr>
<tr>
<td>Trained strength loss (E7-E9)</td>
<td>MOS, Grade, YOS, Type</td>
</tr>
<tr>
<td>Trainee loss</td>
<td>MOS, Type</td>
</tr>
<tr>
<td>Promotion (E3-E5)</td>
<td>MOS, Grade, 1/2 YOS</td>
</tr>
<tr>
<td>Promotion (E6-E8)</td>
<td>Grade, TIG, YOS</td>
</tr>
<tr>
<td>Reclassification</td>
<td>MOS, Grade, Type</td>
</tr>
<tr>
<td>THS factors</td>
<td>MOS, Grade</td>
</tr>
<tr>
<td>Immediate Reenlistment factors</td>
<td>MOS, Grade</td>
</tr>
<tr>
<td>NPS TOS factors</td>
<td>MOS</td>
</tr>
</tbody>
</table>

3Weighted averages are calculated by applying a factor to each of the numbers averaged. The factors sum to 1.0. The larger the factor relative to the other factors, the more influence that number will have upon the calculated average.
different rates. Most of the 300,000 rates used by MOSLS cannot be altered by the user.

**Functions of Pre-Processor.** The pre-processor uses the inputs provided to determine grade limits, estimate MOS trained strength targets, provide inputs for projections, and match monthly accessions to the training schedule.

The “spaces” authorizations do not include every individual in the Service. Thus, MOSLS calculates grade limits to include personnel not assigned to units by considering the individuals account of transients, prisoners, and hospitalized personnel in addition to the authorized “spaces.” The calculated grade limits also reflect legal constraints, such as the limits on the number of E9s in the force, and budgetary constraints.

The MOS trained strength targets are calculated in the pre-processor as an input to the rest of MOSLS. These MOS targets comprise the optimal force for planning purposes. The targets are based upon the sum of authorized spaces to fill, the planned future individuals account, and the space-imbalanced MOS (SIMOS). These SIMOS are positions created to provide a CONUS rotation for a given specialty, such as air defense, which would otherwise exist primarily overseas.

**Training Simulation Model.** The pre-processor also includes the training simulation model, which optimizes the incoming accessions across the existing training class programs. This embedded model considers the incoming accessions; personnel already in the training pipeline; the length of the training session; and the graduation, recycle, and retrain rates in allocating accessions to training programs and projecting the number of graduates. For example, in Figure B.3, the ATRRS might provide information about the training schedule, which informs MOSLS that for MOS A through E there are 300, 300, 300, 400, 50 training seats available, respectively. The training simulation model allocates the incoming 1000 accessions (as per ELIM’s accessions numbers) across those seats. The result might be that

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4 Based upon a weighted average of the historical by-grade distribution of the THS account.

5 Priority is given to small classes, to ensure that they are filled.
shown in the figure, which results in 200 accessions attending the training for MOS D, and 50 accessions in MOS E training. Then the training simulation model applies the information provided by ATRRS on the probable attrition and graduation rates of these accessions to determine the probable number of trained graduates for each of these MOSs. Thus, the final column in Figure B.3 indicates that a total of 800 newly trained individuals will result from this allocation across MOS training courses.

The model does not currently recognize monthly training limitations. In other words, although there are 300 training seats available for MOS A on an annual basis, this quota may result from three scheduled classes of 100 seats each. The current version of the training simulation model in MOSLS might assign 200 of the annual quota in the first month. Soon, however, MOSLS will interface with the PAM seats-available file and will be bound by monthly minimum and maximum training assignments.

Trained Strength Model

The trained strength model is the main element of MOSLS. This portion of the model strives to create the target force defined by the
Description of MOSLS

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The trained strength model produces this output from the calculations of a large-scale network model, which optimizes across policy decisions such as promotion and then simulates individual behaviors to forecast the resulting force out to seven years. The resulting force is compared with the targeted force, and the optimization process is repeated to reduce the difference between the two. Then the model once again simulates the passage of time to produce seven years of forecasts. The optimization routine is repeatedly conducted to minimize the deviation between the target levels and the forecast numbers across MOS and grades. In other words, the model will prescribe transactions, such as promotion, simulate individual behaviors, such as reenlistment, and then compare the resulting answer to a defined optimal target. The next iteration of prescribed transactions and simulated behaviors will produce an answer closer to the target. These cycles are repeated approximately 10 times until the difference between successive model runs is minimal.

Because the network model considers approximately 30 different management transactions (e.g., promotion, reclassification, conversion) across 1,500 different MOSs and grades, for a total of seven years, this portion of MOSLS takes considerable time to run. The run time required for the trained strength model is 22 to 24 hours.

The operation of the trained strength model employs a series of “nodes and arcs.” The nodes represent groups of individuals and the arcs represent transactions, or movement between these groups. Figure B.4 depicts these relationships.

For example, an arc connecting a node labeled “MOS A g1” to “MOS A g2” represents the promotion of an individual from grade 1 to grade 2 while retaining the same MOS. Likewise, movement from “MOS A g1” to “MOS B g1” would occur if an individual changed his skill designator from MOS A to MOS B without being promoted
Movement that denotes both promotion and a change of skill designator could be represented with movement from “MOS A g1” to “MOS B g2.” These are all examples of movements from nodes, which have targeted levels, across arcs, to different nodes, which also have targeted levels. Another kind of movement is that from any node out of the system. In this case, the destination is not another node. Instead, the individual is removed from the system to represent a separation.

These arcs have capacities that limit the movement from one node to another. Nodes connect with multiple arcs. Each arc has both a capacity level and an incentive associated with that capacity. The capacities are calculated relative to the destination node. For example, Figure B.5 shows the arcs to a node representing a high-priority MOS on the left, and those to a low-priority MOS node on the right. The capacity of the first arc to the high-priority MOS node is constrained to 98 percent of the target fill. Once that arc has transferred its limit, the model credits a 100-point incentive. The next 2 percent of the node target is carried by the next arc, which receives a credit of only 10 points. Thus, filling this node to its capacity results in a 110-point
incentive. In contrast, the first arc to the low-priority node is limited to only 95 percent of the target fill, and the model credits only a 50-point incentive. The second arc, which fills the low-priority node to its full capacity by providing the next 5 percent of its fill, receives only a 5-point incentive.

During a model run, the model will fill the first arc of the high-incentive node to receive the most incentive points. The model will then strive to fill the first arc of the low-priority MOS, because the 50 incentive points of the first arc are worth more than the 10 incentive points that would be received by filling the high-priority node to full capacity.

The example arcs and nodes shown also indicate the value of filling all nodes to capacity before overfilling any. The third and fourth arcs in both of the examples carry excess individuals to the destination nodes. In both cases, the model takes away incentive points from the total when nodes are overfilled. Once again, if the model is compelled to overfill either of the nodes, it will overfill the high-priority node, because of the difference in negative incentive points. Should there be additional overflow, the model will determine if it is better to slightly overfill the low-priority node, and suffer a 15-point penalty, than further overfill the high-priority node at the cost of another 90 incentive points.

Each node in the trained strength model has targeted values, and each arc has an assigned capacity and an incentive value to meet that capacity. The users control the capacities and incentives of different nodes by placing relative fill priorities upon the nodes. In general,
the noncommissioned officer (NCO) positions and the current year and nearer outyears have higher priorities than the lower ranking grades and later years.

The trained strength model is a large network of these node-to-node representations of personnel management transactions. Within each time period, individuals travel among the nodes. Figure B.6 represents some of the transactions within a time period. At the left, “MOS X g” represents the individuals of MOS X within grade g. Some of these individuals will continue in the same MOS and grade, and so are shown to the right, in a node of the same label. Others are re-classified, and move along arcs to the pool of people who are reclassified—mandatorily, voluntarily, with reenlistment, or because of model feasibility adjustments. Of that pool, some move into MOS X grade g.

Some individuals are reclassified with conversions and travel one of the arcs shown to MOS Z grade g. They might be Same-Grade Chart Reclassifications (SGCR), which represent normal lateral career progressions. Some SGCR require training; these individuals travel a different arc. The other conversion arcs, one with training and one without, model the transfer of personnel inventory as directed by the manpower managers, such as an administrative change in MOS symbols or an addition or deletion of a MOS, and also force additional flows of individuals for other than normal lateral career progressions, such as to new equipment training.

Two additional inputs to the system are shown at the bottom of the figure. These represent individuals entering the system from the training pipeline and those entering with prior service who do not require training.

In the middle of the figure, some individuals of MOS X, grade g, are promoted. They either move to node MOS X of a higher grade than their previous mode, or they move into the promotion pool, from which they might change both their grade and their skill designator.

At the end of the time period, once all the individual movements across arcs are complete, the model advances a time period. At this time, the model calculates the incentives and disincentives recorded for the priority fills of each node. The model continues to advance in time periods and calculate incentive points. After each complete ad-
Figure B.6—Node and Arc Network of Trained Strength Model
vancement of seven years, the model returns to the current time pe-
period and modifies management actions to reduce the difference be-
tween the targeted force and the result of the last model run by max-
imizing the incentive points received in each run.

One of the personnel management transactions represented in
MOSLS is promotion. Because promotions fall within the Army’s
control, they are optimized, not simulated; they do not occur auto-
matically with the passage of simulated time. The promotions are
constrained by several limiting factors. First, MOSLS recognizes
from the current promotion lists that some individuals have already
been identified for promotions in the near term. Second, promotion
eligibility requirements limit who can be promoted to which grade.
Finally, there are established grade limitations, such as the legisla-
tion that limits the percentage of the total enlisted force who can be
E9s. However, the budgetary constraints are more stringent than the
legislative limits, so the model would promote individuals more gen-
erously than the current fiscal situation dictates were the model not
also user-controlled to restrict promotions.

The MOSLS trained strength model optimizes across all the possible
personnel management transactions, and then simulates the ad-
advance of time. The difference between the answer and the targeted
optimal solution is considered by the model as it repeats the process
with multiple iterations, until the difference between successive runs
is marginal. The trained strength model currently takes 22 to 24
hours of run time to converge to the eventual answer.

The trained strength model can be placed in the context of the entire
MOSLS process by returning to the summary that describes the out-
put of the training simulation model. This process is represented in
Figure B.7. The training simulation model distributes accessions
across available MOS training programs and projects the number of
graduates who will complete each program. The trained strength
model takes those graduates as input to the trained force.
Considering the MOS targets, the grade limits, the projected losses,
and other management transactions, the trained strength model
projects the eventual trained force. In so doing, it also notes the dif-
ference between this projected force and the desired optimal force.
This difference is an input to the training requirements model, dis-
cussed below, which will reevaluate the original allocation of individuals across the training courses offered.

**Post-Processor Module**

The post-processor includes the training requirements model, which reexamines the optimal number of graduates that the trained strength model identified and reallocates the original accessions across the various skill training programs. This process is represented in Figure B.8. Although the training requirements model targets the total number of accessions originally identified by ELIM and input to MOSLS, it is not constrained to these numbers. Thus, the training requirements model recommends a total number of accessions, distributed across the training programs. The output from the training requirements model indicates where changes to the training program, either available seats within a skill or the schedule, are necessary. It will also indicate whether the ELIM accession figures are optimal.

The post-processor manipulates the output of the trained strength model to construct monthly breakouts, by MOS and grade, of such information as trained strength, losses, training graduates, promo-
Figure B.8—Reallocation of Original Accessions

- Accessions
  - 1020
  - 280 → MOS A 300
  - 160 → MOS B 300
  - 120 → MOS C 300
  - 420 → MOS D 400
  - 40 → MOS E 50

- School Seats
  - 250
  - 120
  - 100
  - 300
  - 800

- Projected Graduates
  - 250
  - 120
  - 100
  - 300
  - 800

- Desired Graduates
  - 250
  - 120
  - 100
  - 300
  - 800

- Loss data
  - 250
  - 120
  - 100
  - 300
  - 800

- Grade limits
  - 250
  - 120
  - 100
  - 300
  - 40

- Training Requirements Model

- MOS targets

- Post-processor also compiles totals by MOS, by career management field, by career management field with grades, by total Army, and by total Army with grades. It also manipulates the output to meet the requirements with the various MIS, interface files, and external systems with which MOSLS interfaces.

**SUMMARY**

Like ELIM, MOSLS is a useful tool for Army active enlisted strength management. The main advantage of MOSLS is its integration of multiple personnel functional activities, such as training, promotion, retention, and reclassification, with a tremendous degree of detail. MOSLS provides an organized process for trained strength management with detailed monthly updates to refine prior forecasts and observe the consequences of enlisted trained strength management policies.

Again like ELIM, the analytical techniques are valid and properly employed given the current use of the model. The short-term predictions are typically very accurate, and the long-term predictions...
are reasonably accurate given input assumptions about the changing environment and upcoming policy changes. The monthly runs and associated discussions help to accommodate changes in the Army environment or in other assumptions.

However, the optimization and simulation within MOSLS depend upon the quality of the input data and the assumptions that planned policy changes will be implemented and that unforeseen events or policy changes will not affect the enlisted force. If unexpected policy changes occur or if the policy decisions prescribed by prior MOSLS runs are not implemented, then the model runs will not accurately project the future enlisted force.

An additional limitation of MOSLS is the amount of run time and expertise required to conduct the monthly runs. Frequent “what-if” excursions are not a practical use of MOSLS, and it is unlikely that the Army will ever be able to conduct the monthly MOSLS runs independent of the civilian contractor. The MOSLS results are well documented and available in numerous data reports. However, the reports themselves are not always easily understandable, and the model processes that contributed to the results are opaque and require considerable expertise to explain. Again, the Army will probably not be able to sustain an internal expertise. The extraordinary number of calculations which so complicate MOSLS, however, also provide the level of detail that is so helpful to Army strength management. MOSLS is a valuable element in the strength management process.