

# **Manpower Simulation Model: An Integrated Scenario Analysis, Policy Evaluation, and Forecasting Capability**

## **I. Introduction**

The military manpower mission is to deliver the *right people* to the *right place* at the *right time*. Straight-forward in concept, but difficult to execute because military manpower systems are dynamic operating under complex constraints, where both personnel inventory and warfighting requirements are subject to continuous change. Meeting the manpower mission requires synchronization of many components, including:

- *Force Structure Development Process* to periodically update Tables of Organization and Authorizations by skill, grade, and unit based on warfighting requirements.
- *Inventory Management processes* to align personnel to force structure through processes such as recruiting, training, retention, promotion, and assignments.
- *Resource Constraints* such as budget allocation, end strength caps, and overhead accounts (e.g. T2P2, P2T2, TPPH, or Individual Accounts).
- *A "build from within" structure* comprising vacancy-based promotions with fixed skill-grade flows. Shaping the force requires significant lead time; no lateral acquisitions available to fill capability gaps.
- *Force Control policies* to shape and maintain force health through retention targets, time-in-grade/service restrictions, promotion opportunities and timing, etc.
- *Human Resource policies* to manage career development, health, welfare, pay, benefits, etc. of individuals and their families.
- *Force Allocation and Synchronization* processes to manage operational requirements and allocate personnel to operational formations (e.g. ships, units, platforms, etc.), over time, based on global operational tempo.

Manpower planning and analysis systems have historically relied on discrete, independent models to address individual elements. There are models for recruiting, occupation assignments, promotions, retention, budgets, force overhead (e.g. P2T2, TPPH, etc.), requirements estimation, unit assignments, and many others. What has been difficult to achieve is a modeling capability to analyze plans across time while considering all the system's major factors, processes, and constraints under an integrated framework. This lack of an integrated view challenges the ability to identify unintended consequences and long-term impacts of manpower decisions. And, some questions cannot be adequately addressed at all.

This paper briefly summarizes the key benefits and requirements of a comprehensive, integrated, and dynamic manpower modeling system. This paper also introduces a simulation-based solution already developed with the capabilities to meet these requirements and which can form the backbone of manpower planning and analysis. With such a modeling system, manpower planners gain advanced capabilities for scenario analysis, policy evaluation, and forecasting significantly beyond what a loosely-coupled set of independent models can provide on their own. Fully-employing and continuing to refine this capability will improve insight, support informed decisions, and ultimately support improved performance through better inventory management and risk analysis.

## II. Driving Improved Manpower Planning

An integrated modeling framework provides many potentially game-changing benefits to military manpower planning. The model represents all elements of the manpower system and so becomes a documented expression of the system's logic, processes, business rules, and force shaping and management policies. It serves as an organizing construct, establishing a common operating picture and common basis on which to reason about the system. It provides the ability to experiment with features, processes, and policies to better understand relationships and compare outcomes under varying conditions before attempting to implement changes in the real world, where mistakes are expensive. This section explores some of the most prominent impacts an integrated analytic capability provides:

Analyze Consequences of Decisions Over Time. Because manpower systems are so complex, today's decisions are often not felt for months or years. This means there is often no way to analytically value decisions because of the time lag between cause and effect. A case in point is retention. Retaining too many personnel quickly stymies promotions; retaining too few can lead to grade vacancies. But there is a wide range between these extremes, which can only be evaluated by analyzing the future-year inventory health (in terms of promotion impacts or emergence of vacancies). An integrated modeling framework provides added capability to compare these longer-term effects to drive insight for better decisions now.

Quantifying Uncertainty. An integrated modeling framework provides capabilities to measure uncertainty in two ways. First, it provides ranges and distributions of outcomes so analysts can better understand the difference between expected, best, and worst-case outcomes. Second, and perhaps more importantly, running multiples scenarios with varied assumptions and inputs provides feedback to planners on sensitivity to these factors.

Identify Unintended Consequences. One of the largest deficits of manpower modeling is difficulty understanding relationships between cause and effect across processes and system elements. This is a key strength of an integrated modeling framework. Because the system is represented as it exists in the real world, it will detect planning inconsistencies where a change in one part of the system leads to an unintended consequence elsewhere. Because it operates across time, it captures the compounding effects of these consequences, which can help prevent (or at least identify and mitigate) catastrophic planning errors.

Analysis of Alternatives. A simulation-based modeling framework enables manpower planners to conduct risk-free experiments of numerous alternatives to inform optimized decision-making. This is a huge benefit as it sets conditions to improve operational efficiency across many measures ranging from inventory management to cost analysis to structure development.

Improved Risk Management. Combing all these benefits, an integrated modeling framework achieves a pro-active approach to manpower risk management. Improved forecasting, better understanding of system uncertainty, heightened sensitivity to unintended consequences, and scenario analysis together support a cohesive and complete view of the manpower system. As the collective insight into the manpower system increases, mistakes are fewer and risks become easier to identify and avoid.

*Improved Manpower Readiness.* All these benefits culminate into deeper insight into the operation of the manpower system, its internal relationships, and the effects of planning decisions both across the system and across time. As insight improves so does the quality of decision support. The net effect is improved readiness through improved inventory management, improved costs, or a combination of both.

### III. Modeling Framework User Requirements

An integrated manpower modeling capability must be organized around the operational needs of manpower planners. The table below provides the *Users* and *User Stories* which such a capability must support. *Users* represent various perspectives on the manpower system. *User Stories* define what a given *User* needs to be able to do with the model.

*Note: All User Stories should be viewed with respect to changes over time. That is, the objective is time-based or evaluating the impact of an analytic question is a measurement of effects over time.*

User	User Stories
As a <b>Plans and Policy Director</b> , I want to be able to...	<ul style="list-style-type: none"> <li>• Rapidly analyze numerous planning alternatives with a combined, risk-based view of impacts to end strength, budget, promotions, retention, recruiting, and fit-to-fill across occupations, grades, and units.</li> <li>• Provide defensible estimates of supportability to force structure planners.</li> <li>• Assess impacts and trade-offs in policy choices (e.g. what impact does changing reenlistment length have?)</li> <li>• Have confidence that plans are coordinated to capture unintended consequences.</li> <li>• Better understand long-term consequences of decisions.</li> </ul>
As an <b>End Strength Planner</b> , I want to be able to...	<ul style="list-style-type: none"> <li>• Develop forecasts cognizant of, and consistent with, recruiting, promotions, and retention.</li> <li>• Quickly estimate uncertainty in end strength forecasts.</li> <li>• Rapidly analyze numerous planning alternatives based on different assumptions about the future.</li> <li>• Better understand how changing force structure can drive change in attrition behavior.</li> <li>• A second opinion on isolated end strength models.</li> </ul>
As a <b>Promotion Planner</b> , I want to be able to...	<ul style="list-style-type: none"> <li>• Develop promotion plans consistent with changes in recruiting and retention.</li> <li>• Rapidly analyze numerous planning alternatives based on different assumptions about the future.</li> <li>• Better understand how policy choices (e.g. changing grade limits, changes to structure, promotion freezes, etc.) will affect my promotion plans.</li> <li>• Better monitor inventory management policies for their risk to promotion flows and timing.</li> </ul>

<p>As a <b>retention planner</b>, I want to be able to...</p>	<ul style="list-style-type: none"> <li>• Develop retention plans consistent with changes in recruiting and promotions.</li> <li>• Rapidly analyze numerous planning alternatives based on different assumptions about the future.</li> <li>• Identify retention requirements (across occupations, grades, and zones) that balance skill-grade flows of the force to keep promotion flow rates within healthy ranges.</li> <li>• Better understand and plan for lateral moves across occupations.</li> </ul>
<p>As an <b>assignments/distribution planner</b>, I want to be able to...</p>	<ul style="list-style-type: none"> <li>• See future risks/gaps in inventory so I can plan unit assignments accordingly.</li> <li>• Evaluate manning and staffing across multiple inventory scenarios.</li> </ul>
<p>As a <b>Force Structure planner</b>, I want to be able to...</p>	<ul style="list-style-type: none"> <li>• Assess strengths/weaknesses of T/Os and Authorizations against inventory build scenarios to inform structure development.</li> <li>• Assess manning/staffing prioritizations and precedence levels against inventory build scenarios to help tune priority levels.</li> <li>• Evaluate force structure plans with respect to cost and inventory supportability.</li> </ul>
<p>As a <b>Budget planner</b>, I want to be able to...</p>	<ul style="list-style-type: none"> <li>• Rapidly cost multiple manpower scenarios over time.</li> <li>• Test and evaluate relationships between cost drivers and inventory management decisions.</li> </ul>

**IV. The Manpower Simulation Model**

The Manpower Simulation Model (MSM) was developed between 2012 and 2014 to provide an integrated manpower planning and analysis framework aimed at the benefits and user stories previously discussed. The MSM was validated by the Naval Postgraduate School in 2016 and has open research funding to develop a graphical user interface. The model, in its current form, has supported a wide range of analysis for Marine Corps manpower ranging from supporting retention plans to analysis of gender-based recruiting policies to analyzing Cyber growth scenarios. This section summarizes model’s key features and capabilities along with some example analytic questions the model supports.

**Key Features and Capabilities**

*Fully replicates manpower system.* Integrates models of all key manpower components, including:

- Individual servicemembers are represented as model “agents” who flow through the manpower system and age into future years.
- Network- and vacancy-based skill-grade flows dynamically constructed based on Military Occupational Specialty Manual (MOS Manual) definitions.
- Recruiting/Accessions. Model estimates recruiting by occupation or takes user input.
- Classification. Individuals are assigned occupations based on demand.

- Attrition/Losses. Estimates attrition by numerous categories and by occupation and grade.
- Retention. Estimates retention by occupation, grade, and retention zone or accepts user inputs of the same.
- Lateral Moves. Estimates lateral moves by occupation and grade, or accepts user inputs of the same.
- Promotions. Estimates promotions based on grade vacancies, using defined business rules and promotion processes.

*Rapidly forecasts up to an arbitrary number of future years.* Model makes inventory projections by year, month, occupation, and grade for as many years as user specifies. Full model run (including pulling source data) completes in minutes.

*Model is Interactive.* Model estimates all required variables (e.g. recruiting goals, retention, etc.) in aggregate and by occupation, grade and across time. However, users may override any inputs (e.g. specify required recruiting missions, % of males vs. females to recruit, zone retention, etc.) and the model will estimate remaining variables. This bi-directional “sandbox” approach allows model and user to interact for a wide variety of analytical tasks.

*Dynamically Sources Data.* Data queries are automated. Users can specify combinations of time frames for data pull to vary assumptions related to historical rates.

*Robust Output Data.* Produces over 80 manpower-related analysis variables at various aggregation levels (total force, occupation, grade) across months and years. User may control the aggregation levels.

### ***Analytic Capabilities***

Because MSM represents the essential elements of the real-world manpower system, users can obtain analytical outputs on almost any aspect of the system. The table below provides a limited set of example analytic questions organized along relevant system components.

NOTE: All questions should be viewed with respect to how they are expected to change over time.

<b>Component View</b>	<b>Sample Analytic Questions</b>
Force Structure	<ul style="list-style-type: none"> <li>• What effect does structure or grade shape have on vacancies, promotion timing, average years of service, failed promotion selections, force-outs from service limits, etc.?</li> <li>• Can inventory support proposed structure, grade shape, etc.?</li> <li>• Can inventory support manning/staffing prioritizations?</li> <li>• How much overhead (P2T2, T2P2, TPPH) does this force structure profile imply?</li> </ul>
Promotions	<ul style="list-style-type: none"> <li>• What is the impact of freezing or reducing promotion execution?</li> <li>• What is the effect of varying selection opportunity?</li> </ul>

	<ul style="list-style-type: none"> <li>• What is the selection rate of promotion-eligible individuals under Scenario X?</li> <li>• How does average promotion time change under Scenario X?</li> </ul>
End Strength	<ul style="list-style-type: none"> <li>• What effect does changing end strength targets have on vacancies, promotions, years-of-service, time-in-grade, failed promotion selections, time-in-service limit losses, cost, etc.?</li> </ul>
Retention	<ul style="list-style-type: none"> <li>• What effect does changing retention targets have on retention rate, vacancies, end strength, recruiting, etc.?</li> <li>• What should be the retention mission (total, by occupation, grade, zone).</li> </ul>
Recruiting, Lateral Moves	<ul style="list-style-type: none"> <li>• What is the required recruiting mission consistent with end strength targets and retention?</li> <li>• What effect does varying recruiting missions have on end strength, promotion timing, etc.?</li> <li>• How many females should be recruited to maintain x% of the force?</li> <li>• What recruiting mission supports healthy growth of force (or healthy force reduction)?</li> </ul>
Cost Analysis	<ul style="list-style-type: none"> <li>• How much overhead is expected? Remaining available manning?</li> <li>• What is the cost/manned billet?</li> <li>• How does overhead change by adjusting time to train?</li> <li>• What is the cost differential between Scenarios A and B?</li> </ul>
Other	<ul style="list-style-type: none"> <li>• What is the effect of changing contract length?</li> <li>• What is the effect of shifting annual recruit distribution?</li> <li>• How many individuals (by occupation, grade) will be available to fill unit vacancies?</li> <li>• What is the expected fit-to-fill under Scenario X?</li> <li>• How does our inventory change if we change force controls (service limits, grade limits, selection opportunity, etc.)?</li> <li>• What is a healthy growth profile for occupation X?</li> </ul>

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