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M&RA Manpower Models Modernization

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USMC MANPOWER MODELS MODERNIZATION

EXECUTIVE SUMMARY

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Project Summary

In his planning guidance, the Commandant states "We will ... accelerate our transformation from disconnected legacy systems to an integrated data architecture that treats data as it should be –a critical resource" (Berger, 2019, p. 15). This project is a bold step in support of that transformation for Manpower & Reserve Affairs (M&RA), which possesses numerous mathematical models that support the management of the human resources development process (HRDP). Our approach demonstrates how M&RA can leverage the latest technology in data architecture and decision support models to overcome these deficiencies. We formulate modernized versions of models to fill the roles currently held by the Total Force Planning Model (TFPM) and the Enlisted End-Strength Planning Model (ESPM). In addition, we formulate a discrete event simulation model to analyze changes in structure that currently has no legacy counterpart. We successfully replicated the TFPM in Python and identified a number of improvements that should be made with respect to data formatting. An inability to obtain sufficiently accurate separation data prevents progress towards replication of the ESPM. Finally, we successfully implemented a discrete event simulation of the manpower system. While initial validation attempts appear favorable, a more complete validation is prevented by the same inability to obtain appropriate data.

Keywords: *United States Marine Corps, USMC manpower planning, human resources development process, decision support, operations research, total force planning model, enlisted end-strength planning model, machine learning, discrete event simulation*

Background

In his planning guidance, the Commandant states "We will ... accelerate our transformation from disconnected legacy systems to an integrated data architecture that treats data as it should be –a critical resource" (Berger, 2019, p.15). This project is a bold step in support of that transformation for M&RA, which possesses numerous mathematical models that support the management of the HRDP. In general, these models suffer from the following limitations:

a) Models tend to be implemented in an outdated computational language.
b) Models tend to require substantial human intervention to manage the interface between models, as when the product of one model is a required input for another model in the process.
c) Models tend to require substantial human intervention to manage the interface between the model and sources of empirical data such as Total Force Data Warehouse (TFDW).
d) Models tend to lack standardization with respect to elements common among models. For example, several models might require an estimate of the attrition rate for, say, Marines of a particular rank and occupational specialty, yet each model might contain a differently calculated rate.

In addition, some processes within the HRDP lack any sort of decision support tool, but could benefit from the addition of such a tool, provided it is sufficiently user friendly and sufficiently interoperable with other models and data sources.

Our approach demonstrates how M&RA can leverage the latest technology in data architecture and decision support models to overcome these deficiencies. We focus on the following three lines of effort (LOEs).

LOE 1: Formulate a model that fills the role in the HRDP that the legacy Total Force Planning Model currently fills. Given the Authorized Strength Report and various budgetary and policy constraints as inputs, this model produces an ideal inventory by grade and military occupational specialty (MOS) for the present fiscal year and six future years. We provide analysis as to the feasibility of implementing such a model in Python as well as the benefits such a model could bestow. In addition, we consider ways to make the model more capable and more user-friendly than the legacy TFPM.

LOE 2: Formulate a predictive machine-learning-based model that fills the role in the HRDP that the legacy Enlisted End-Strength Planning Model (ESPM) currently fills. Given historical attrition behavior and the planned accession mission, this model provides a within-execution-year forecast to determine the likelihood that the system will meet the target enlisted end-strength at the end of the fiscal year.

LOE 3: Formulate a discrete event simulation model to assist in the analysis of changes in the structure of a given Occupational Field (OccFld). Given a notional target inventory for that OccFld; the current inventory for that OccFld; historic attrition behavior; and the relevant Enlisted Career Force Controls; this model produces an estimate of the resultant promotion timing for each grade, as well as an estimate of the feasibility of obtaining the desired inventory levels. We provide an analysis of the feasibility of implementing such a model in Java.

Findings and Conclusions

LOE 1: We successfully implemented a replication of the TFPM for officers in Python using a parallel processing approach. We processed all 257 combinations of MOS and officer type with FY22 data and compared those against the official TFPM outputs and produced identical results in 244 out of 257 cases. The other 13 instances contained discrepancies that were reviewed by a domain expert. Some discrepancies were caused by manual adjustments and others were categorized as errors. We provide detailed recommendations for improvements in four key areas. We identify significant disadvantages with the data formats we received, including inconsistent field naming conventions from one data table to another, and implicit representations that are understandable to a human analyst but insufficient for machine processing. These data formatting deficiencies increase the complexity of logic and code required for generating the TFPM.

LOE 2: We assess the legacy ESPM and formulate a predictive machine-learning-based ESPM. We had hoped to estimate this model to illustrate its feasibility in replacing the legacy model. Unfortunately, we encountered extreme challenges collecting the necessary data. As of the writing of this report, we are still awaiting key data elements in order to estimate this model. The model and results will be part of the FY23 study, beginning with Major Aaron Falk's March 2023 thesis.

LOE 3: We successfully formulated and implemented a discrete event simulation model of the manpower system in Java. Given a notional target inventory for an OccFld, the current inventory for that OccFld, historic attrition behavior, and the relevant Enlisted Career Force Controls, the model provides estimates of expected promotion timing for each grade, expected accession mission, and expected retention requirements. The model easily employs data-farming techniques and lends itself to both transient and steady-state analyses. While initial validation attempts demonstrate that the model appears to perform well, this aspect of the project was plagued with the same data

collection issues as LOE 2, and much less time was available for validation. Therefore, we recommend to continue the validation efforts into the future, both with respect to additional target years and additional communities and MOSs. Researchers should confirm the existence of proper time to promote data as well as empirical retention data. It is likely that minor refinements to the manner in which Marines in the above-zone for promotion are managed, as well as minor refinements to how reenlisted Marines are distributed across grades will prove worthwhile and improve model performance.

Ultimately, the most important finding of this project is that the records contained in TFDW might be insufficient to support building a rigorous mathematical model of attrition behavior. Namely, the reason for a Marine's separation from active duty does not appear to be properly archived. The Marine Corps will fail in its efforts to transform from an industrial age organization to an information age organization if the data it relies on to make the most elementary manpower management decisions (i.e. the effort to make end-strength) is flawed or non-existent.

Recommendations for Further Research

First, the Marine Corps should make steps to ensure that the reason(s) that a Marine separates from active duty is properly archived and is easily retrievable for purposes of analysis. The difficulty in collecting this and other relevant data prevented any real progress towards replication of the Enlisted End-strength Planning Model (ESPM) (line of effort [LOE] 2) and hampered validation efforts of the model we analyze in LOE 3. Given this lack of progress, we recommend continuing work on the ESPM.

Upon conclusion of Aaron Falk's March 2023 thesis, the model he develops and analyzes in that thesis will be delivered to Manpower & Reserve Affairs (M&RA). Due to statutory restrictions on the appropriate uses of Navy Research Program funding, the other models we analyze in this project cannot be delivered. We recommend M&RA seeks other channels to replicate this research and develop models that can be lawfully delivered and implemented.

References

Berger, D.H. (2019). *Commandant's Planning Guidance*. U.S. Marine Corps.

Acronyms

ESPM	Enlisted End-strength Planning Model
HRDP	human resources development process
LOE	line of effort
M&RA	Manpower & Reserve Affairs
MOS	military occupational specialty
OccFld	occupational field
TFDW	Total Force Data Warehouse
TFPM	Total Force Planning Model
TTP	Time to Promote