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Improving Navy MPTE Studies with Model-Driven Big Data

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IMPROVING NAVY MPTE STUDIES WITH MODEL-DRIVEN BIG DATA

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EXECUTIVE SUMMARY

Project Summary

The goal of this research was to improve upon the ability of OPNAV N1 analysts to quickly and efficiently obtain experiment-based information from their computational models. The enhanced information will enable N1's analysts to better support Navy leadership in resource and policy decisions that shape the future Navy and help it retain and develop its most talented Sailors. This project built on previous collaborations with N1 using data farming to enhance the information gleaned from their Navy talent management models, such as the Officer Strategic Analysis Model (OSAM) model, the Production Resource Optimization (PRO) model, and the Navy Total Force Strength Model (NTFSM). During this research period, (1) Ensign William Desousa (2015) investigated the behavior of economic inputs in NTFSM; (2) Lieutenant Peter Bazalaki (2016) used the new data farming capabilities we developed in OSAM to investigate Surface Warfare Officer (SWO) inventory across a breadth of possibilities; and (3) Lieutenant Allison Hogarth (2016) built, tested, and demonstrated a user interface in Excel that enables users of the PRO model to automatically execute a sophisticated design of experiments—the tool that enables this new capability is known as Production Resource Optimization Model With Experimental Design (PROMWED). In addition to working with the student-officers, the faculty supporting this project performed an empirical study of statistical software packages that may provide better understanding of the high-dimensional behavior of manpower models in the future (Erickson, Ankenman, & Sanchez 2016).

Keywords: Navy talent management, manpower, recruiting, data farming, simulation, design of experiments.

Background

Navy planners face the challenge of balancing manpower requirements and mandated end strength with budget constraints. The uncertainties associated with human behavior and economic factors complicates forecasting end strength and developing policies that ensure that the Navy has Sailors with the right skills in the coming years. The Chief of Naval Personnel (N1) is responsible for analyzing manpower inventory forecasts and estimating the Navy's manpower requirements and expenditures. His

findings affect the budget and Program Objectives Memorandum (POM) submitted to the Secretary of the Navy every two years.

The Chief of Naval Personnel has a dedicated staff that provides him with the necessary information and associated risks to make decisions on manpower, such as where and how recruiting resources should be spent. Of course, forecasting Navy personnel levels is a complex problem compounded by numerous uncertainties. Therefore, the staff relies critically on manpower, personnel, training, and education (MPTE) models that allow them to project future force levels given a set of assumptions and historical experience. Three models used for manpower analysis at N1 are the Navy Total Force Strength Model (NTFSM), the Officer Strategic Analysis Model (OSAM), and the Production Resource Optimization (PRO) model. These models, and others used at N1, have many input variables and generate multiple outputs of interest. Such models may be more useful to N1 analysts if they are embedded in an environment that allows analysts to quickly and efficiently obtain experiment-based information. The SEED Center advanced the ability to data farm all three of these models during the performance period covered in this report.

Findings and Conclusions

New software was developed, tested, and applied in data farming proof-of-concept applications with NTFSN, OSAM, and PRO. In one application, Lieutenant Peter Bazalaki (2016) utilized the new data farming capabilities in OSAM to simulate Unrestricted Line Officer (URL) inventory over a seven-year period. Specifically, his research used design of experiments (DOE) to project Surface Warfare Officer (SWO) inventory across a variety of assumptions, including a proposed Enhanced Probationary Officer Continuation and Redesignation (EPOCR) policy. He found that current policy will reduce FY2016 URL inventory by 8% over a seven-year period, and over-execute SWO inventory authorizations by 40%. However, if implemented correctly, EPOCR has the potential to decrease the operating standard deviation to modest levels with minimal risk of under-execution.

ENS Desousa (2015) investigated the behavior of economic inputs to NTFSM. After manually implementing a sophisticated design of experiments (DOE), he simulated and analyzed a variety of scenarios to better understand the behavior of NTFSM and to

determine the sensitivity of the user defined economic factors. The results of the analysis unexpectedly showed that NTFSM's economic factors have no significant impact on NTFSM's end-strength output—this unanticipated finding warrants further investigation.

Ongoing research is underway with the PRO model by LT Allison Hogarth. She is building, testing, and using an intuitive and easy-to-use user interface in EXCEL that enables users to run a sophisticated design of experiment over a breadth of input variables. LT Hogarth has named this new capability the Production Resource Optimization Model With Experimental Design (PROMWED), see Hogarth et al. (2016). She is testing and assessing PROMWED on an N1-approved scenario.

Naval Postgraduate School faculty continue with their research in developing design of experiment algorithms that improve upon our ability to explore high dimensional models of manpower (and beyond). This past year we performed a large-scale empirical study of several Gaussian process (GP) software packages, and found differences in their suitability for creating metamodels of high-dimensional behavior (Erickson, Ankenman, & Sanchez 2016). This is a first step toward enhancing recent work on sequential methods (Duan, Ankenman, Sanchez, & Sanchez 2017) in order to develop adaptive methods that dynamically focus on interesting parts of the trade space as experiments are executed and evaluated.

Recommendations for Further Research

Follow-on work has already commenced. NPS student-officers who are participating in this research will shortly be coordinating with OPNAV N1 staff—in partnership with SEED Center researchers—to identify studies and models (e.g., NTFSM) that will use and test the data farming capabilities being developed. If the new capabilities in OSAM, PRO, and NTFSM prove valuable, they will be applied to support other N1 studies such as the results of various policy options on retention. Additional models used by N1 will be considered as candidates to make data farmable. If requested, focused workshops will be scheduled to facilitate adoption of the new data farming capabilities by N1 analysts.

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