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IMPROVING NAVY RECRUITING WITH DATA FARMING

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ABSTRACT

Secretary of the Navy Ray Mabus states that people provide "the Navy and Marine Corps' greatest edge" (Mabus, 2015). To help recruit and manage this dynamic workforce of more than 300,000 active duty Sailors, the Navy uses mathematical models and simulation to assess the potential impacts and risks of changes to force structure, budgets, policies, and the economy. One important model is the Planned Resource Optimization (PRO) model. PRO is currently being used to inform recruiting resourcing decisions. The decisions may involve, for example, advertising, enlistment bonuses, number of production recruiters, etc. A limitation of PRO is the lack of an interface to facilitate extensive experimentation. This paper summarizes an effort underway to enhance the analytic utility of the PRO model by embedding it in a data farming environment. This enhanced tool is called the "Planned Resource Optimization Model with Experimental Design" (PROM-WED).

1 INTRODUCTION AND BACKGROUND

Manpower and personnel costs consume a substantial portion of the U.S. Navy's budget. The active duty Navy has over 300,000 Sailors. To maintain this force, around 40,000 new Sailors are recruited each year. Moreover, the recruits need specialized skills for the increasingly high-technology Navy to accomplish its mission. The Chief of Naval Personnel (N1) is responsible for analyzing manpower inventory forecasts and estimating the Navy's manpower expenditures, including recruiting. A dedicated staff provides him or her the necessary information and associated risk assessments to make decisions on manpower. Forecasting Navy personnel levels is a complex problem with numerous uncertainties, e.g., future economic conditions and human variability. Therefore, the staff relies critically on simulations and models of manpower, personnel, training, and education (MPTE), including the Planned Resource Optimization (PRO) model, to allow them to project future force levels and needs given a set of assumptions and historical experience.

PRO is a deterministic non-linear optimization model that, given constraints, provides users with a recommended set of resources to achieve a given recruiting mission. PRO can also be used to estimate recruiting capacity for a given level of resources. The PRO model is implemented in Microsoft Excel using both worksheet functions and Visual Basic for Applications (VBA) code. PRO's primary function is to provide a broad estimated budget picture of Navy Recruiting resource allocation in support of the Program Objectives Memorandum (POM), which must be submitted to the Secretary of the Navy every two years. PRO is also used to answer questions, such as what is the least expensive way to meet a recruiting mission? Or, how much money do we need to allocate for advertising to achieve a high likelihood of meeting a given recruiting goal?

PRO contains numerous input variables, many of which are uncertain, such as future unemployment rates and the elasticities of responses to advertisement and enlistment bonuses. The goal of this research is to provide tools and methods that simulate and account for this uncertainty, thus enabling N1 to utilize PRO more effectively to find and support robust resource and policy decisions that shape the future Navy and help recruit skilled Sailors. We are doing this by adding VBA code and new worksheets to provide PRO

users with the ability to automatically run a sophisticated design of experiments over multiple input variables. The enhanced tool is called the Planned Resource Optimization Model with Experimental Design (PROM-WED).

2 THE NEW PLANNED RESOURCE OPTIMIZATION MODEL WITH EXPERIMENTAL DESIGN (PROM-WED)

Most PRO users are not experts in the design of high-dimensional experiments for computational models. They simply desire a tool that is easy to use and provides them with good designs without the need to call in statistical experts. Latin hypercubes (LHs), and especially nearly orthogonal LHs (or NOLHs), are a family of designs with good space-filling properties (Cioppa and Lucas 2007) that we have found to be extremely valuable. NOLHs provide computational researchers with design and analysis flexibility. Design flexibility means that they can readily obtain designs for a broad set of input factors (numbers and types) and sampling budgets. Analysis flexibility provides the ability to fit many diverse meta-models to multiple outputs and generate a wide variety of visual relationships.

PROM-WED enables analysts to easily use NOLHs. The NOLH spreadsheet tool "NOLHDesigns_v6.xls: Generating nearly orthogonal Latin hypercube designs", which is available for download from the SEED Center for Data Farming (http://harvest.nps.edu) at the Naval Postgraduate School (NPS), is embedded into PROM-WED through the use of extra worksheets and VBA code. A graphical user interface (GUI) allows the user to set-up a NOLH design for their choice of multiple inputs. The model then projects several fiscal years into the future over all of the design points for a user specified number of replications. "Decision factors," such as the number of production recruiters in the field and the amount of money spent on advertising, are within the Navy's control. These factors directly affect the budgetary estimates that support OPNAV N1's POM inputs to Congress. Other controllable factors may include policy choices. For example, a policy may dictate the required percentage of recruits that are high quality versus the percentage of recruits that have a high school diploma. There are also "noise factors," such as the unemployment rate and the number of qualified military available, these are uncontrollable circumstances that affect the recruiting environment and must be part of the analysis.

PROM-WED allows the user to explore multiple factors and set restrictions on decision factors to give policy and decision makers a broad risk assessment picture of the potential effects of their choices. Additional capabilities of PROM-WED include the ability to select from a family of experimental designs, save scenarios, produce descriptive statistics on output variables, and generate data suitable for further analysis in advanced statistical software, such as JMP.

3 CONCLUSION

PROM-WED provides Navy manpower analysts with a new capability to obtain robust insight into the best use of recruiting resources through scenario based excursions and tradeoff analyses. Specifically, it allows analysts to quickly and efficiently obtain experimental information over many more input variables than was previously possible. PROM-WED is currently being used in a test case analysis.

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