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Efficiently Using Families of Diverse Models to Better Inform Decision Makers in Objective and Repeatable Ways

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NPS NRP Executive Summary
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Period of Performance: 10/19/2020 – 10/23/2021
Report Date: 10/18/2021 | Project Number: NPS-21-M238-A
Naval Postgraduate School, Graduate School of Operational and Information Sciences (GSOIS)

EFFICIENTLY USING FAMILIES OF DIVERSE MODELS TO BETTER INFORM DECISION MAKERS IN OBJECTIVE AND REPEATABLE WAYS

EXECUTIVE SUMMARY

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Prepared for:
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Project Summary

The United States Marine Corps seeks to integrate analytical processes that develop actionable insights for decision makers across its enterprise. One supporting goal in this endeavor is to develop a methodology for implementing a wargame-analytic continuum by formally linking outcomes of wargames with more traditional, constructive closed-form simulations.

The primary research objective was to explore methods and tools that provide the greatest utility when integrating wargames with constructive simulations, and this was accomplished via three main steps. The first step was to work with thesis students, each of whom studied a topic of current interest to the Marine Corps, assisting them with (1) the development of a constructive simulation scenario and (2) the design, execution, and analysis of one or more experiments. The second step was to use the simulation-based effort to infom a wargaming activity. The third step was to conduct a literature review and produce a synthesis of findings and recommendations for future work.

The three student topics chosen were (1) anti-surface warfare battery lethality and survivability in expeditionary advanced base operations (EABO), (2) Marine infantry company lethality in a Force Design 2030 construct (Headquarters Marine Corps, 2020) and (3) cannon artillery lethality and survivability in a Russia counterbattery scenario. The first of these used the Modeling and Simulation Toolbox (MAST) simulation, and the latter two used the Map Aware Non-uniform Automata (MANA) simulation. Upon completion of their constructive simulation work, each used their data and insights to inform a sponsored wargame, under the auspices of the Operations Analysis (OA) 4604 Wargaming Applications Course.

A literature review was conducted and insights gained were synthesized with the students' practical applications. Finally, a set of recommendations, best practices, and potential pitfalls for linking constructive simulation to wargames was developed. This work included capturing key concepts graphically through "loop of loops" and "sequence of iterations" diagrams.

Keywords: *wargaming, constructive simulation, cycle of research, design of experiments, expeditionary advanced base operations, EABO*

Background

As the Marine Corps focuses its efforts on implementation of Force Design 2030—a major change in organization, equipment, and concepts employment—it has an urgent need to analyze its tactics, techniques, and procedures (TTP) with respect to employment of anti-surface warfare missile systems in EABO. At the same time, study is needed to determine how traditional Marine Corps capabilities need to adapt within this new context. Perhaps like no time in the recent past, the use of multiple modes of analysis and inquiry are crucial to studying and implementing such major change. Such modes include wargaming, analysis, typically using constructive simulation, and field experiments and exercises. These

modes can be implemented and integrated within a continuous "cycle of research," a term coined by Peter Perla in his seminal book, *The Art of Wargaming* (1990).

The primary goal was to explore methods and tools that provide the greatest utility when integrating wargames with constructive simulations. By working with three thesis students, each with an identified topic of current interest to the Marine Corps, the study began by assisting each with the development of a constructive simulation scenario. Subsequently, each simulation scenario was methodically explored using one or more efficient and flexible experimental designs and high-performance computing assets. The output was studied using a variety of graphical and statistical methods.

The first student topic (Fitzmaurice, 2021) was anti-surface warfare battery lethality and survivability in EABO, and a base scenario was developed using the MAST simulation framework. Designs of experiment varied several tactics and parameters related to battery lethality and survivability, for example, the use of an air defense missile system and active radar, concealment measures, anti-surface missile performance specifications, and timing of displacement.

The second student topic (Harper, 2021) was Marine infantry company lethality in a Force Design 2030 construct, and a base scenario was developed using MANA. Designs of experiment varied parameters and tactics related to the use of unmanned aerial vehicles (UAVs), sensor coverage, and the opposing force's use of UAVs and naval surface fire support.

The third student topic (Kadrmas, 2021) was cannon artillery lethality and survivability in a Russia counterbattery scenario, and a base scenario was developed using MANA. Designs of experiment varied parameters and tactics related to cannon artillery organization (consolidated versus levels of distributed operations), cannon performance specifications, and opposing force use of both cannon and multiple launch rocket system (MLRS) artillery assets.

Upon completion of the analysis, each of the students used the data and insights to inform a sponsored wargaming activity. Additionally, a literature review was conducted and insights gained were synthesized with the students' practical applications. Finally, a set of recommendations for linking constructive simulation to wargames was developed.

Findings and Conclusions

Several interesting and important findings emerged from each student's constructive simulation-based effort. The effort focused on the employment of anti-surface warfare missile systems within EABO produced the following main findings: (1) Effectively engaging enemy ships from maximum effective missile range allows for both an increase of successful strikes against hostile ships and a decrease in friendly casualties; (2) selective and efficient use of friendly radar systems decreases the probability of

being detected by enemy ships while still affording protection from enemy missile threats; and (3) remaining undetected by conducting survivability moves and use of overhead concealment dramatically increases survivability of friendly units ashore.

The effort focused on the Marine infantry company in a Force 2030 construct produced the following main findings: (1) Engaging at maximum effective range is superior to mass surprised fires at the company level for this scenario; (2) victory is best generated by the force that first finds and employs sufficient loitering munitions on the other side; and (3) enabling a restricted operations zone where the future company commander owns airspace to a sufficient altitude and can self-clear all fires in his domain is critical to success.

The effort focused on the employment of cannon artillery in a Russian scenario produced the following main findings: (1) Equipment currently fielded is largely in line with the most significant factors for lethality and survivability; (2) significant changes to current TTPs are necessary for force protection and mission success, namely adopting a more segmented and distributed employment of cannon artillery; and (3) inclusion of an MLRS capability by an adversary increases casualties for both sides and should be designated as a high-value target and prioritized for targeting.

Upon completion of the constructive simulation analysis, each of the students used the data and insights gained to inform a sponsored wargaming activity, under the auspices of the OA4604 wargaming applications course. Two of the students informed the Marine Littoral Regiment wargame sponsored by the Marine Corps Warfighting Laboratory, and the third student informed a Force Design 2040 wargame sponsored by the Australian Defence Force. The wargaming efforts were informed both qualitatively and quantitatively. For example, wargame performance specifications and player options were informed with information developed for or produced by the constructive simulation. Additionally, results from the constructive simulation-based analysis was used to shape the wargame player's available options, and in some cases, suggested how to adjudicate. Wargame results that corroborated similar findings from constructive simulation research were recorded, and qualitatively different results were discussed to probe possible causes and generate additional hypotheses.

Finally, insights gained from the literature review were synthesized with the students' practical applications. We developed a set of recommendations, best practices, and potential pitfalls for linking constructive simulation to wargames. We also developed two diagrams, named "loop of loops" and "sequence of iterations," to illustrate the key concepts graphically.

Recommendations for Further Research

Three potential areas for useful research were identified in this study of methods for integrating wargames with constructive simulations. The first is to gain familiarity with Command Professional Edition, a

commercial wargaming and simulation environment in use by the Marine Corps Warfighting Laboratory and the Standard Wargame Integration and Facilitation Tool (SWIFT), a government-owned tool designed to allow games to be created, manipulated, recorded, and replicated in a digital environment.

The second area of future research is to investigate the extent to which Command Professional Edition and/or SWIFT might be used as the basis for post-wargame experimentation and analysis. Specific features of Command Professional Edition would be examined to determine the level of effort required to translate and automate human decision making within a data farming environment.

Finally, in consultation with the topic sponsor, a focused area of study would be selected and used as the basis to further develop the constructive simulation to wargame (or vice versa) link, given specifics of the problem and the simulation/software environments available to support the effort.

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Acronyms

EABO expeditionary advanced base operations
MANA Map Aware Non-uniform Automata
MAST Modeling and Simulation Toolbox
MLRS multiple launch rocket system
OA operations analysis
SWIFT Standard Wargame Integration and Facilitation Tool
TTP tactics, techniques, and procedures
UAV unmanned aerial vehicle