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NPS NRP Executive Summary
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Period of Performance: 03/01/2019 – 04/30/2020
Report Date: 04/30/2020 | Project Number: NPS-19-M027-A
Naval Postgraduate School, Graduate School of Operational and Information Sciences (GSOIS)

Evaluating/Improving Representation of Intelligence Capabilities And Processes in Combat Modeling with Demonstration in Combined Arms Analysis Tool for The 21st Century (COMBATXXI)

EXECUTIVE SUMMARY

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Student Participation: No students participated in this research project.

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Project Summary

The 2016 United States Marine Corps (USMC) Operating Concept describes an enhanced concept of intelligence that enables the force to "establish and maintain battlespace awareness, influence the operating environment, and support decision-making at higher headquarters and on down to the point of action" (United States Marine Corps [USMC] 2016, p. 19). Simulating such capabilities requires representation, up and down the command hierarchy, of intelligence collection, processing, dissemination, and utilization as well as representation of battlefield effects resulting from the availability and application of such intelligence. Representation of these processes in combat simulations is critical in influencing combat outcomes, which provide an analytic basis for warfighting requirements and system acquisition decisions. As the USMC and US Army evolve capabilities and tactics, techniques, and procedures in the area of intelligence, models must be able to represent current intelligence capabilities as a baseline for studies, and must be modifiable to enable analysts to represent future capabilities for comparison.

This Naval Research Program (NRP) broad area study investigated and evaluated current capabilities implemented in the USMC/US Army Combined Arms Analysis Tool for the 21st Century (COMBATXXI), the primary analytic simulation used by both services to support studies of future warfighting systems, capabilities, and methodologies. While addressing broad intelligence processing modeling considerations, the project examined specific effects of intelligence modeling on scenario execution outcomes and recommended improvements to COMBATXXI capabilities.

The study team found there is no systematic representation of the intelligence process in COMBATXXI, and key functional components (e.g., data fusion) need improvement. Based on our analysis, the team recommended the following: a set of specific changes to the simulation logic, the need for follow-on work to create a coherent representation of the intelligence process in the simulation, and further investigation of interactions between the improved intelligence model and communications modeling in COMBATXXI.

Keywords: c*ombat modeling, intelligence process, behavior representation, Combined Arms Analysis Tool for the 21st Century, COMBATXXI*

Background

The 2016 Marine Corps Operating Concept describes an enhanced concept of intelligence as follows: "Current and future forces will increasingly rely on sensors, networks, architectures, and tradecraft to establish and maintain battlespace awareness, influence the operating environment, and support decision-making at higher headquarters and on down to the point of action. ... [We] must seek to capture the value of pushing networked intelligence down to tactical units throughout the MAGTF [Marine Air-Ground Task Force]" (USMC 2016, p. 19).

Simulating capabilities described in the operating concept requires representation of intelligence collection, processing, dissemination, and utilization up and down the command hierarchy, as well as representation of battlefield effects resulting from the availability and application of such intelligence. In combat simulations, these processes must influence combat outcomes that provide an analytic basis for warfighting requirements and system acquisition decisions. As the USMC and US Army evolve systems, tactics, techniques, and procedures in the area of intelligence, models and simulations must be able to represent current intelligence capabilities as a baseline for studies, and must be modifiable to enable analysts to represent future capabilities for comparison.

In recent years, the Naval Postgraduate School (NPS) Modeling, Virtual Environments, and Simulation Institute has developed tools and behaviors in the USMC/US Army COMBATXXI simulation to express ship-to-shore maneuver plans and execution, as well as fire mission plans and execution supporting USMC studies. These efforts took similar approaches in re-assigning assets as prior simulated mission assignments are completed, permitting the processes to proceed automatically throughout a scenario. For example, Harder (2017) prototyped an automated planner for maneuver and fire. Using advanced terrain reasoning, subsequent NPS students have added capability to Harder's framework for maneuver planning. Although these efforts provide a proof-of-principle for the proposed intelligence modeling approach, they generally have been limited to a single layer of the command hierarchy. Modeling intelligence planning, collection, processing, exploitation, and dissemination needs to exhibit the fractal property of self-similarity across all levels of the command hierarchy. That is, the representation of intelligence at each layer of the command hierarchy must consider characteristics that are found at each level, such as: (1) the layer of interest has direct authority over some set of intelligence assets; (2) the layer of interest may request intelligence assets from a higher authority; (3) the layer of interest can direct the use of intelligence assets under the command authority of a subordinate; and (4) the layer of interest may request intelligence assets under the command authority of some adjacent force. This conceptual similarity at each level of the command structure provides an effective starting point for designing generic system logic and behaviors that can be assigned to any level. In short, a model of the intelligence process needs to consider assets available, capabilities of those assets in space, time, and collection characteristics, as well as recognition of the kind of missions that need to be performed (from which information requirements can be derived).

Findings and Conclusions (to include Process/Methodology)

The purpose of this NRP broad area study was to evaluate and improve the representation of intelligence in combat simulation, with demonstration of capabilities using the USMC and US Army COMBATXXI simulation. Since COMBATXXI is an important analytical tool for conducting studies, the USMC has interest in understanding its capabilities to support studies of different mixes of intelligence assets and processes on warfighting effectiveness.

To address the purpose of the study, the research team performed the following tasks:
1). Requirements Analysis: The study team obtained a current set of requirements from the Marine Corps sponsor and derived a set of software requirements for the intelligence model from a study of doctrine and tactics, techniques, and procedures applicable to the major elements of the intelligence process.
2). Conceptual Modeling: The study team developed a preliminary conceptual model of the intelligence process to identify principal objects and interactions that need to be represented to address the intended use and derived requirements. This portion of the project identified algorithms and data needed to represent capabilities and processes in the simulation.
3). Simulation Design: The study team identified new capabilities needed in the target implementation environment (COMBATXXI), including improvements to capabilities that may be present currently in the simulation.
4). Simulation Implementation: The study team implemented selected aspects of the identified design to demonstrate potential opportunities for supporting studies of intelligence capabilities in the Marine Corps.
5). Recommendations: The study team recommended future actions to improve the modeling capabilities of simulations such as COMBATXXI.

While addressing the broad modeling considerations, the study team investigated and evaluated current capabilities implemented in the COMBATXXI. The team conducted experiments with the current implementation to examine simulation outcomes and to recommend improvements to COMBATXXI capabilities. Although COMBATXXI provides a number of functional capabilities relating to particular aspects of intelligence planning, collection, processing, and dissemination, the study team found that it has no comprehensive approach that can support such studies. The study outlined a methodology for planning and employing sensor assets to provide information needed by simulated warfighters at various levels of command in the situation under study. The study identified current shortfalls for improvement and described a full model of the intelligence process for consideration in future development projects.

Recommendations for Further Research
The study recommended that the Marine Corps continue research and development to address key requirements stated in the 2016 Marine Corps Operating Concept; specifically, the study team considered the following areas from the operating concept to be ready for immediate follow-on work to this Naval Research Program study. First, enhanced simulation can explore data strategies and information sharing architectures to achieve benefits from machine-aided tipping, machine-aided relational visualization and display of battlefield threats, and opportunities that help commanders and other decision makers quickly and intuitively understand complex situations. Second, simulation can examine use of unmanned intelligence, surveillance, and reconnaissance systems that can provide actionable in ways that support distributed units with highly compressed timelines for situation awareness, intelligence, decision-making, and action. Third, simulation can investigate the inherent opportunities in viewing every aircraft and

every vehicle, potentially even every individual Marine, as a battlefield sensor. Fourth, simulation can examine effects of task-organizing Marine Air-Ground Task Forces (MAGTFs) to include mission-appropriate intelligence capabilities through a consistent approach to develop Marines qualified to staff mutually supporting intelligence nodes across all MAGTF organizations, and developing a tailorable common operating picture that can be distributed based on mission and user needs (USMC 2016, p. 19). Preliminary steps toward such capabilities were demonstrated as part of this study.

Specific recommendations for improvement of COMBATXXI included: design and implementation of identified improvements to the COMBATXXI data fusion logic, and design and development of complete behaviors representing the intelligence process (planning and direction, collection, processing and exploitation, analysis and production, dissemination and integration, evaluation and feedback) at all levels of the command hierarchy.

Each of these operating concepts can be represented in models and simulations, such as COMBATXXI, to provide a foundation for evaluation of alternative systems, tactics, techniques, and procedures. Without such rigor, it will be difficult to impossible to understand the complex interrelationships found in the various combinations of collection assets, organization, information flows, and data structures, all in the presence of a determined enemy intent on disrupting warfighter performance. Of course, such representations also serve as a basis for modeling enemy processes that US forces seek to disrupt in kind.

Lastly, there is an interesting interplay of the overall intelligence process with other areas of investigation in combat modeling for Marine Corps studies; namely, modeling communications and modeling human physiology and psychology. Intelligence collection and dissemination rely on communications capabilities that can be degraded, denied, or distorted by enemy actions or characteristics of the physical battlespace. The ability to interpret and analyze collected information and perform effective decision-making, when these activities are not fully automated, depend on the physical and cognitive condition of the human decision makers (Shattuck et al., 2007). Given these factors, the study team also recommended continuing research to model the complex interplay of intelligence, communications, and human physiology/psychology to create greater opportunities for studying key factors in the modern battlespace that lead to success or failure of combat operations.

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Acronyms

COMBATXXI	Combined Arms Analysis Tool for the 21st Century
MAGTF	Marine Air-Ground Task Force
NRP	Naval Research Program
NPS	Naval Postgraduate School
USMC	United States Marine Corps