MARINE CORPS ANALYTIC MODELING AND SIMULATION

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ABSTRACT

The Marine Corps has instituted a new Mission Area Analysis (MAA) process to identify operational requirements and deficiencies. In the past, the MAA process was subjective and somewhat lacking in analytic rigor. The new methodology extensively employs the capabilities of models and simulations to provide quantifiable findings as the basis for the Marine Corps Combat Development Process. Prior to this effort, the on-site analytic modeling capability of the Marine Corps Combat Development Command (MCCDC) was limited. The newly formed MAA Branch conducted a survey of existing and developing simulations, and produced a plan to rapidly expand MCCDC's analytic tool set. An initial suite of models was selected and installed to provide insight across the functional areas of maneuver, fires, command and control, ISR (Intelligence, Surveillance, and Reconnaissance), logistics, and force protection. The very nature of Marine expeditionary operations across the domains of land, sea, and air added to the complexity of the task. This paper will discuss the evolving analytic modeling capabilities of the Marine Corps.

1 OVERVIEW

Mission Area Analysis (MAA) studies are conducted by the military services to identify operational requirements and deficiencies across a broad range of functional areas. The overall goal is to provide a sound basis for key resource allocation decisions, and to focus attention on issues involving Doctrine, Organization, Training, Equipment, and Support (DOTES) of forces. Although the Marine Corps had long conducted such studies, senior leaders recognized the need to add analytic rigor to the MAA process. The MAA Branch was formally established in the Studies and Analysis Division of the Marine Corps Combat Development Command (MCCDC) in May 1997 to accomplish this objective.

MCCDC had previously divided MAA's into twelve separate functional areas and relied almost exclusively upon the opinions of subject matter experts for the analyses. At the end of a three-year cycle, this process yielded a series of twelve independent reports, each containing a prioritized list of perceived deficiencies. Since the subjective assessments were conducted without regard to any specific mission, scenario, or set of tactical conditions, the magnitude of these deficiencies could not be quantified. Also, because the studies were conducted separately by functional area there was no mechanism for capturing the interactions between these areas, or to rank deficiencies overall across functional areas. It became apparent over the years that "stove-piped" analyses producing unquantifiable "wish lists" provided limited insight to the Marine Corps' Concept Based Requirements Process (CBRP).

MCCDC sought to rectify these problems by creating a totally new methodology for conducting MAA's. Using the pillars of concepts and doctrine, the new MAA process was designed to identify and quantify required capabilities and deficiencies across a wide spectrum of operational environments defined by approved scenarios. The first step was to identify a set of five to eight relevant scenarios based on current guidance and initiatives, which would encompass a broad range of operational missions, threats, and conditions.

The goal was to find or develop the "minimum spanning set" of scenarios to help define the very essence of the Marine Corps from Major Theater Wars (MTWs), which form the bedrock of our national military strategy, to Small Scale Contingencies (SSCs), which drive the day-to-day operational tempo of our forces. These scenarios must depict Marine forces employed in joint operations according to advanced warfighting concepts. The base year for the studies were set to last year of the upcoming Future Year Defense Plan, roughly eight to ten years in the future. This timeframe provides an important bridge between the fiscal realities of today and advanced warfighting concepts and technologies of tomorrow.

MCCDC sought to create a comprehensive, yet flexible methodology. Rather than committing to any specific tool or technique, the new MAA's would employ a

variety of analytic techniques to include modeling and simulation (M&S), spreadsheets, war games, experiments, literature reviews, historical research, as well as subject matter expert assessments. The analysts match the most appropriate set of tools to the analytic requirements of the study depending on the specific scenario and the issues. Thus, the new MAA process conducts studies by scenario across all functional areas while striving to strike a balance between quantitative and qualitative techniques. The new process soon became known as "Hybrid Analysis" to emphasize the need to blend the best aspects of numeric techniques with opinion-based methodologies. It was evident from the start that MCCDC's analytic modeling capability needed to be rapidly expanded in order to achieve this balance, and to provide a quantifiable basis for the MAA's.

2   ANALYTIC MODELING AND SIMULATION

Analytic combat simulations generate data, which would otherwise be unobtainable in the real world due to high cost or unavailability. Analysis of simulation data can provide critical insight to decision makers for a variety of purposes to include: 1) determining the appropriate mix of forces to conduct an operation or campaign; 2) assessing possible courses of action; 3) evaluating the effectiveness of various equipment alternatives; and 4) refining emerging concepts and doctrine. Unlike training simulations, which are designed to create a realistic environment to stimulate personnel in near real time, analytic simulations seek to remove the "man in the loop" to eliminate the effects of human variability from the output data. Closed form simulations enable controlled experiments to be modeled in which variations in battle end states can be directly traced to changes in input. Each simulation run is usually much faster than real time depending on the size, complexity, and resolution of the combat model.

Combat simulations should not be used in a predictive role to forecast probable end states of conflicts. No matter how complex these computer-based systems may be, warfare will always be an orders of magnitude more complex and chaotic endeavor. However, plausible approximations of a battle or campaign can be modeled with appropriate technical, operational, and scenario data. The true worth of combat simulations lies in comparative analysis in which the impact of specific input changes can be directly linked to specific battle outcomes. Analytic models, when properly employed, will enable MCCDC to quantify many of our requirements and deficiencies, which would otherwise remain unmeasurable.

The Marine Corps' perspective toward analytic M&S has rapidly evolved over the past decade. Although the importance of training simulations has been long supported in the Marine Corps, analytic M&S capabilities were mostly ignored up until the early 1990's. Most decision-makers were far more comfortable with the results yielded from qualitative methods such as war games or the venerable BOGSAT ("bunch of guys/gals sitting around a table"). This prevailing view changed dramatically with the emerging need to justify requirements for the MV-22 and AAAV programs. Only combat simulations could measure a specific system's contribution to the ultimate outcome of a battle. MCCDC launched intense efforts to conduct Cost and Operational Effectiveness Analysis (COEA) studies on both systems, and hired external contractors to perform the extensive M&S support required. Although the MV-22 and AAAV COEA's were successfully completed and had significant impact, the scenarios modeled in these studies could provide no additional insight to decision makers on other related issues because MCCDC lacked the organic capability to run state of the art combat simulations. Exclusive reliance on external contractors for combat modeling was prohibitively expensive in the long run.

The recent Quadrennial Defense Review (QDR) proved to be a turning point for the Marine Corps. MCCDC was invited to join the U.S. Army's TRADOC Analysis Center (TRAC) to form a joint study team for the Close Support End-to-End Assessment (CSEEA). CSEEA was a J-8 sponsored study initiated by the Joint Requirements Oversight Council (JROC) to examine required capabilities needed to fight the close battle as part of the on-going QDR. The study's methodology extensively employed combat modeling to enable the quantitative analysis of weapon platforms, munitions, sensors, and command and control systems. Teamed with TRAC and leveraging off joint funding, MCCDC established an in-house modeling capability with limited technical support from contractors. The QDR highlighted the fact that in an era of tighter budgets, the Marine Corps would need a quantifiable basis for forces, programs, and required capabilities. This important conclusion, combined with the acknowledged need to enhance the analytic rigor of the MAA's, led to MCCDC's rapid expansion of analytic M&S capabilities under the MAA Branch. Due to strict constraints upon the government service work force, on-site contractors were hired to round out the military analysts and operational experts already resident in MCCDC.

3   FINDING APPROPRIATE MODELS

Once the decision was made to expand M&S capabilities, determining which tools to acquire and install became the focus of effort. This was not a trivial matter. Marine expeditionary operations touch all warfare domains from the sea, to the land, and in the air. The set of scenarios, which provide the foundation for the MAA process, span the spectrum of conflict from humanitarian operations to high intensity combat operations and portray forces from high to medium levels of resolution. The requirement to

address all functional areas (redefined into six broad areas per the Uniform Joint Task List) also added substantial complexity to the task. The MAA Branch conducted a thorough survey of analytic models and simulations, which provided a "roadmap" for acquisition and installation. The objective was to develop a time-phased plan for building M&S capabilities tied to providing analytic support for Program Objective Memoranda (POM) which are driven by a two year cycle. The M&S survey highlighted that a suite of models were required to support the new MAA process – no single model could "do it all".

The short-term suite, installed and operational within the first six months, consisted of three models: 1) the General Campaign Analysis Model (GCAM), 2) Extended Lanchester Model (ELAN), and 3) Tactical Logistics and Distribution System (TLoaDs). GCAM is the Navy's primary analytic model. It is a flexible tool with variable resolution designed to readily integrate the results of other models. It is really more of a modeling environment, with a ready made tool kit for an analyst to employ, than a traditional combat simulation. GCAM can graphically represent the ship-to-shore movement of an amphibious operation all the way down to the individual landing craft and helicopter if necessary. It's ability to simulate naval operations and track the flow of forces and logistics ashore were essential to expanding the realm of our M&S capabilities. Joining the GCAM users community also strengthen our ties to other analytic agencies throughout the Department of the Navy.

ELAN, originally developed by TRAC, is a basic ground combat simulation capable of representing joint operations. ELAN's level of resolution is ideally suited to portray conflict in the scenario set planned for the MAA studies. Having already been successfully used by MCCDC for the Lightweight 155mm Howitzer COEA and CSEEA, it had the added advantages of being on hand as well as easy to use. ELAN generates detailed killer-victim scoreboards, both from unit on unit and weapon system on weapon system perspectives, which are essential for conducting detailed analysis of ground combat. Using ELAN, even a small modeling team can build a large scenario database in a matter of weeks.

TLoaDs is a logistics model currently under development by Marine Corps Systems Command using the "Extend" commercial simulation environment. TLoaDs is a planning and analysis tool specifically designed to represent logistics assets and activities in naval expeditionary operations. A "beta" release of TLoaDs was installed so that MCCDC could help to test, refine, verify, and validate the model. Although TLoaDs has not been formally used to conduct an MAA study as yet, it shows tremendous promise to provide meaningful insight on logistics issues of particular concern to the Marine Corps.

4   EXPANDING THE SUITE OF MODELS

Although the short-term suite of models rapidly established our M&S capabilities, the coverage of some functional areas was admittedly weak in some areas. The MAA Branch developed a broad list of measures of effectiveness (MOE's) without regard to any specific scenario or model. Of theses generic MOE's, the combination of GCAM – ELAN – TLoaDs could generate data on just under 50% of them at best. Coverage in the areas of Intelligence, Surveillance, and Reconnaissance (ISR) and Command and Control (C2) was particularly lacking. Thus, the initial M&S capability was further expanded to the intermediate-term suite with the addition of the Vector-In-Commander (VIC) model in May '98.

VIC is the Army's primary model for analyzing Corps and Division sized battles. In addition to the detailed representation of ground combat, VIC has extensive C2 and ISR capabilities. It has become one of the primary tools in the joint community for conducting sensor-to-shooter studies. TRAC is currently developing an amphibious module to improve VIC's capability to portray forcible entry operations. In a cooperative arrangement, the MAA Branch is helping to define software requirements and test this module. The amphibious module will accept a detailed landing plan as input, execute the landing by a variety of amphibious vehicles, landing craft, and helicopters, and then dynamically adjust the landing plan for the loss of landing craft and helicopters in earlier waves. When completed, the amphibious module in VIC will enable the seamless analysis of ship to objective maneuver.

With the addition of VIC, MCCDC is now the only analytic agency in the world capable of running the primary analytic models of both the U.S. Army and U.S. Navy. We've come a long way in a just a year. By having a common set of tools, significant opportunities exist for joint efforts between the Army, Navy, and   Marine Corps. This includes such activities as developing scenarios, building   joint databases, and conducting joint studies. Based on the recent example of CSEEA, such exchanges have continued between these services since the QDR, and discussions are ongoing to establish more cooperative efforts in the future. Over the past twelve years, the operating forces of the services have made great strides in working together in a joint environment; the analytic communities of the services now seem poised to make similar strides to the benefit of all.

There are many long-term initiatives in the realm of analytic M&S of interest to the Marine Corps. The fidelity of models continues to improve dramatically, offering the opportunity to put better tools in the hands of military analysts. Two model development efforts in particular have drawn our involvement: 1) the Joint Warfare System (JWARS), and 2) Combat XXI. JWARS is a joint theater-

level analytic model under development by the Office of the Secretary of Defense, Program Analysis and Evaluation. JWARS will replace the aging TACWAR model by providing a more balanced representation of warfare across land, sea, and air while offering enhanced logistics and C4ISR functionality. MCCDC is actively engaged in defining requirements for this effort as a member of several joint working groups and will become a "beta" test site for an early release of the combat simulation. The Initial Operational Capability (IOC) for JWARS is currently scheduled in FY00.

Combat XXI is a high-resolution combat simulation being developed at TRAC - White Sands Missile Range as a state of the art replacement for the Army's CASTFOREM model. Recognizing the importance of building joint analytic tools, TRAC and MCCDC have recently signed a Memorandum of Agreement to co-develop this model to ensure it meets the requirements of both services. Combat XXI will eventually become the tool of choice for studies requiring entity-level modeling of combined arms operations. As a high-resolution model, it will provide an important complement to JWARS.

5 SUMMARY

Although the potential of analytic M&S had not been fully appreciated in the past, the value of quantitative analysis and improved tools has now been firmly established at MCCDC. The concept of "Hybrid Analysis", employing qualitative and quantitative techniques in a cohesive and mutually supporting fashion, is working within the MAA Branch to determine required warfighting capabilities and deficiencies. Decision-makers have come to expect far more from our analysts than the re-hashed opinions of "BOGSAT's". MCCDC will continue to explore opportunities for improving our combat modeling capabilities through cooperative arrangements with other services, and active participation in developing the next generation of analytic models.

AUTHOR BIOGRAPHY

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