Wargaming and Combat Modeling for Analysis

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Introduction

The United States Department of Defense (DoD) has long utilized simulations of combat to help understand how to equip and employ its forces in preparation for future combat operations. In order to properly equip and employ forces, decisions on equipping and employing forces are almost always made by forecasting potential adversaries and combat scenarios decades into the future, and then analyzing what equipment and formations DoD will need to develop and field to enable successful mission accomplishment in the future.

An Abbreviated History of Wargaming

Before the advent of the computer, the primary form of combat simulation used by DoD was wargaming. Wargaming has a rich history and has been used by many cultures and in many different forms. The games of Chess, India's four-player chess-like game called Chaturaji, and the ancient Chines game Go are but a few of the games that were believed to have usefulness in training and testing military commanders' decision-making capabilities. In the 19th century, the Prussians developed Free and Rigid Kriegspiel as a way to test their officers. Free Kriegspiel used battle-tested Prussian officers to assess junior officers as they were taken on staff rides and presented with possible combat situations that they had to react to. Rigid Kriegspiel focused on the calculations of combat, with the hypothesis that good combat leaders had to be able to employ a sort of 'combat calculus' to mathematically understand what decisions should be made on the battlefield. In the first half of the 20th century, the U.S. Navy made great use of wargaming to examine a potential war with Japan, beginning over two decades of focused gaming in 1919 at the U.S. Naval War College. This detailed examination of war in the Pacific proved to be so successful that, after the conclusion of World War II, Admiral Chester Nimitz said "…nothing that happened during the war was a surprise - absolutely nothing except the Kamikaze…" As the North Atlantic Treaty Organization (NATO)-Warsaw Pact Cold War consumed DoD for the latter half of the 20th century, the types and fidelity of wargaming began to change. As computing capabilities developed, some of the 'bookkeeping' of wargaming (e.g. accounting for the physics-based aspects such as movement rates, distances between weapon systems and units, calculating lines of sights, tabulating fuel and ammunition expenditures, and eventually assessing attrition of units in contact) was automated. By the early 1970's, the idea of fully automating wargames became a reality, and there were now ground combat simulations that had very simplistic but completely automated

decision algorithms that replaced human input. These "closed-loop" combat simulations allowed for the assessment of 30, 60, or even 90 days of ground combat at an operational- or theater-level without any human direction aside from starting the computer model. Similar tactical-level ground combat simulations were developed that could assess a tactical battle of 24-48 hours looking at a brigade-level fight. It was at this stage of computerization that the distinction between wargaming and other forms of combat simulations became blurred, so we will pause and outline the differences.

Terms of Reference: Wargames and other Combat Simulations

In historical terms, modern-day wargames are much like the Prussians' Free Kriegspiel, while today's closed-loop combat simulations mirror the Rigid Kriegspiel model.

A wargame is indeed a combat simulation, although the word 'simulation' does not imply that a computer is required. We will adopt the definition of a wargame that Peter Perla offered at the 2007 Military Operations Research Society Wargaming Workshop: "A warfare model or simulation that does not involve the operations of actual forces, and in which the flow of events shapes and is shaped by decisions made by a human player or players."

Closed-loop combat simulations are not wargames, as there are no human decisions that impact the flow of events of the operations simulated in the computer model. In closed-loop ground combat simulations, the decisions that humans would make are simplistically scripted, such as "attack if you have a better than three-to-one ratio of combat power over your adversary" or "travel from point A to point B and attempt to destroy any enemy vehicle that you identify and can shoot at." Closed-loop simulations provide the means to assess the technological merits of weapon systems and formations given that the decision that those forces will engage in battle has been already been made.

However, there is ample room for confusion. DoD also utilizes "Human-in-the-Loop" or HITL combat simulations. These combat simulations are, in most cases, computer-based wargames. The entities in these HITL combat simulations require near-continuous human input to move and fire weapon systems during the course of the simulated operation. The command of each competing force in an HITL simulation is exercised by a human commander throughout the operation.

Wargames and Closed-Loop Combat Simulations for Analysis

Toward the end of the 20th Century, the use of computerized combat simulations combined with other factors to relegate wargaming to a little-used tool for analysis. The dominant scenario that the United States DoD used to underpin their acquisition decisions was the NATO-Warsaw Pact battle for Europe. This battle had been analyzed continually for decades and both sides' intelligence had been so well

developed that nearly the entire world understood how the battle on the north German Plain would unfold—attack corridors, force compositions and equipment, even opposing commanders were all known. Tom Clancy's book "Red Storm Rising" provides a very realistic look at what that encounter would have looked like, and underscores the amount of information commonly available about that potential conflict. The dominant school of thought seemed to be that there was no need to develop courses of action or get fresh subject matter expertise on the battle to be fought—all that was left was the fight itself.

However, US Army analytic organizations realized that closed-loop combat simulations could not be relied upon as the single tool needed to do analysis. While the automated decision rules allowed for the development of stochastic models that could be run numerous times to ensure there was a representative set of battle outcomes, the automation of the human decision-making process was recognized to be too simplistic to rely on for a complete assessment of combat operations. Both the Army's Center for Army Analysis (CAA) and the Training and Doctrine Command Analysis Center (TRAC) developed analysis protocols that first used wargames to thoroughly examine different courses of action (COAs) before deciding on a single course of action that was then scripted into their closed-loop combat simulations.

In the post-9/11 era, the US DoD has begun to realize that both wargames and closed-loop combat simulations have important and distinct roles in the analytic process. US involvement in Iraq and Afghanistan has highlighted that counterinsurgency and stability operations cannot be simulated in existing closed-loop combat simulations. While agent-based simulations show promise in helping us to understand human behavior in regions of conflict, there are no closed-loop simulations that parallel those used by DoD to analyze major combat operations. Wargaming has taken on a more prevalent role since 9/11, although there have also been major efforts to develop computer simulations to analyze counterinsurgency and stability operations. One such simulation, the Peace Support Operations Model (PSOM), was developed by the United Kingdom's Defence Science and Technology Laboratory, and has been used extensively over the past decade. This is not a closed-loop simulation, but a simulation that requires human decision-making at each turn—a computer-based wargame.

Conclusion

Both wargames and closed-loop combat simulations will continue to have roles in analysis. Wargames will continue to help us understand trade-offs in Courses of Action development and will play a major role in the creation and development of new employment concepts and new tactics, techniques, and procedures as new weapon systems and capabilities are integrated into our fighting forces. Closed-loop combat simulations will continue to provide the capability to assess the physics-based qualities of our forces and will allow us to tabulate, in the absence of any human input, the relative technological merits of new weapon systems and new formations.

Author Biography

Jeff Appleget has been Senior Lecturer in the NPS Operations Research Department since May 2009. He retired as an Army Colonel with 30 years of service, 20 of those as an Army OR analyst. He holds a BS from the US Military Academy (1979), MS in Operations Research and Statistics from Rensselaer Polytechnic Institute (1989) and a PhD in Operations Research from the Naval Postgraduate School (1997). As an Army analyst, Jeff played a key role in CAA's analysis of Desert Storm, directed the TRADOC Analysis Center-Monterey, held key leadership roles conducting the analysis of the Army's Future Combat Systems (FCS) program, and was a member of the development team of the Irregular Warfare Tactical Wargame developed at TRAC. He teaches the Wargaming Analysis, Combat Modeling, Statistics, and co-teaches Modeling and Simulation of Societies in Conflict courses at NPS. He also designed and developed a week-long Wargaming course that was most recently taught at the Canadian Forces Aerospace Warfare Centre in Trenton, Ontario. He teaches UN peacekeeping operations and designs and conducts peacekeeping simulation exercises for the US Partnership for Peace Training and Education Center (USPTC). His research interests include irregular warfare and counterinsurgency, survey data modeling and analysis, peacekeeping operations, verification, validation, and accreditation (VV&A) of models and data, combat modeling, wargaming, and integer programming. He served on the Military Operations Research Society (MORS) Board of Directors from 2000-2004. He was a member of the NATO SAS-091 Specialist Team (2012 Research and Technology Organization Scientific Achievement Award winner) that developed metrics to support decisions for the transition of responsibilities from ISAF to the Afghanistan Government. His other major awards include the Army Modeling and Simulation Office Analysis Award (2011), Dr. Wilbur B. Payne Memorial Award for Excellence in Analysis (1991 and 2003), Simulation and Modeling for Acquisition, Requirements, and Training (SMART) Award (2001 and 2003), and 1990 Concepts Analysis Agency Director's Award for Excellence.