

MINDGAMES: ALTERING SIMULATIONS USE AT THE BRIGADE LEVEL

A Monograph

by

MAJ Ali J. Besik
United States Army



School of Advanced Military Studies
United States Army Command and General Staff College
Fort Leavenworth, Kansas

2014-001

REPORT DOCUMENTATION PAGE			Form Approved OMB No. 0704-0188		
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing this collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports (0704-0188), 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number. PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.					
1. REPORT DATE (DD-MM-YYYY) 22-05-2014		2. REPORT TYPE Monograph		3. DATES COVERED (From - To) July 2013 - May 2014	
4. TITLE AND SUBTITLE Mindgames: Altering Simulations Use at the Brigade Level			5a. CONTRACT NUMBER		
			5b. GRANT NUMBER		
			5c. PROGRAM ELEMENT NUMBER		
6. AUTHOR(S) BESIK, ALI J.			5d. PROJECT NUMBER		
			5e. TASK NUMBER		
			5f. WORK UNIT NUMBER		
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) U.S. Army Command and General Staff College ATTN: ATZL-SWD-GD 100 Stimson Ave. Ft. Leavenworth, KS 66027-2301			8. PERFORMING ORGANIZATION REPORT NUMBER		
9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)			10. SPONSOR/MONITOR'S ACRONYM(S)		
			11. SPONSOR/MONITOR'S REPORT NUMBER(S)		
12. DISTRIBUTION / AVAILABILITY STATEMENT Approved for public release; distribution is unlimited.					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT The US Army's training for staff officers has consistently been identified as one of the major factors for US military success over the last century. As technology has improved the Army has sought to replicate many facets of this training with computer simulations. While the use of automation yields benefits as the force utilizes technology in real world operations, developing technological based systems has potential drawbacks that other training methods may alleviate. Traditional manual simulations, utilizing analog technology as simple as paper and maps, offer training benefits that have been neglected in the push towards automation. As budgets in the near future continue to shrink these alternative methods offer the potential to achieve the Army's stated goals of producing adaptable and flexible leaders and units at a fraction of the cost, particularly at the Brigade level.					
15. SUBJECT TERMS Simulations, Wargames, Modeling, Staff Training, Brigade Staff, Simulation and Modeling, Manual Simulations, Analog Simulations, Decision Making					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES 50	19a. NAME OF RESPONSIBLE PERSON
a. REPORT UNCLASSIFIED	b. ABSTRACT UNCLASSIFIED	c. THIS PAGE UNCLASSIFIED			19b. TELEPHONE NUMBER (include area code)

MONOGRAPH APPROVAL PAGE

Name of Candidate: MAJ Ali J. Besik

Monograph Title: MINDGAMES: Altering Simulations at the Brigade Level.

Approved by:

_____, Monograph Director
Alice A. Butler-Smith, Ph.D.

_____, Seminar Leader
Michael Swanson, COL, AV

_____, Director, School of Advanced Military Studies
Henry A. Arnold III, COL, IN

Accepted this 22nd day of May 2014 by:

_____, Director, Graduate Degree Programs
Robert F. Baumann, Ph.D.

The opinions and conclusions expressed herein are those of the student author and do not necessarily represent the views of the US Army Command and General Staff College or any other governmental agency. (References to this study should include the foregoing statement.)

ABSTRACT

MINDGAMES: Altering Simulations at the Brigade Level, by MAJ Ali J. Besik, 40 pages.

The US Army's training for staff officers has consistently been identified as one of the major factors for US military success over the last century. As technology has improved the Army has sought to replicate many facets of this training with computer simulations. While the use of automation yields benefits as the force utilizes technology in real world operations, developing technological based systems has potential drawbacks that other training methods may alleviate. Traditional manual simulations, utilizing analog technology as simple as paper and maps, offer training benefits that have been neglected in the push towards automation. As budgets in the near future continue to shrink these alternative methods offer the potential to achieve the Army's stated goals of producing adaptable and flexible leaders and units at a fraction of the cost, particularly at the Brigade level.

ACKNOWLEDGEMENTS

The author would like to thank LTC Robert Young, Mr. Richard Hannon, Mr. Carl Meinke and the staff of the National Simulation Center for their time spent answering questions and allowing for the observation of systems under development. Regardless of how the budget is spent there are dedicated and intelligent people developing systems to enhance Soldiers training. Dr. Alice Butler-Smith, Dr. Pete Schifferle, COL Michael Swanson, Mrs. Candace Hamm and the rest of the faculty and staff at the School of Advanced Military Studies made this monograph possible.

TABLE OF CONTENTS

	Page
TABLE OF CONTENTS	v
TABLES	vi
MINDGAMES	1
HOW SIMULATION WARGAMING GOT TO THE PRESENT	9
DIFFERENCES IN TRAINING GOALS AND SIMULATIONS PROCUREMENT	17
BETTER ENABLING COLLECTIVE TRAINING GOALS	30
CONCLUSION	36
BIBLIOGRAPHY	41

TABLES

	Page
Table 1. The Army Principles of Unit Training.....	19

MINDGAMES

In the whole range of human activities, war most closely resembles a game of cards.

—Clausewitz, *On War*, Book One

Clausewitz's remark about war and a game is an apt reminder of the applicability of gaming methods to train decision makers. In the modern US Army this type of training is often facilitated by computer simulations. The Army uses computer models and simulations for a variety of tasks. From training individual tasks to predicting the outcome of corps maneuvers in a national level conflict the Army has invested hundreds of millions of dollars into the development and utilization of various simulation systems. Many of these systems allow individuals or units to train under various conditions to prepare for real world missions. This variety of conditions would be difficult to replicate in the real world given financial and physical limitations. They also enable multiple iterations of the same conditions to be rehearsed for comparison. The Army has created an entire functional area to oversee the development of these simulations and their integration into training at all levels.

This monograph discusses the benefits provided by Army simulations that are used to conduct training at the brigade and battalion level. The reasons for this focus are that Brigade Combat Teams and Support Brigades have become the primary units that deploy in support of US overseas military operations. Additionally Brigades are generally the largest unit that conduct field exercises or other types of collective training, thus providing some measure of comparison between the benefits of simulated training and actual live exercises. For the last three decades, the US Army has attempted to develop computer based simulations to make tactical training easier and more available to its constituent brigades.

The following pages argue that, in return for the hundreds of millions of dollars spent on computer models and simulations, such as wargames, the Army's benefit in training value to its

brigades has been negligible. Furthermore it is the position of this paper that the Army would see greater return on investment by adopting a form of manual simulation. For clarity “manual simulations” are systems which do not rely on computers or electronic mechanisms to be used. Manual simulations, they rely on paper, such as maps, and written word, generally books, to be utilized. Computers can be used in support of manual simulations for ease of information handling, but the processes which guide the simulation are rules and guidelines in print as opposed to lines of code being processed by a computer. Manual simulations of this type are often described commercially as wargames. For the purposes of this paper the term “wargame” is used to refer to simulation systems as opposed to the US Army’s doctrinal definition of wargame in the Military Decision Making Process.

There are three main points to this argument. First that the cost of developing these computer based wargames is wasteful particularly as budgets shrink in the near future. Second that these systems as currently fielded have been developed with technological considerations as the primary concern as opposed to training objectives. Lastly that there are educational and training benefits from utilizing manual systems that would better support the US Army’s stated desire to train adaptable leaders. Thus the Army should adopt manual wargames as a more cost effective alternative to the computer based systems it has consistently attempted to develop over the last twenty-five years.

There are over thirty computer based modeling or simulations systems that the Army currently uses to fulfill some of the various requirements mentioned above, from training to development to predictive analysis. In 2004 eight were used to train staff’s at the brigade and division level. At the time the Army planned to develop three new systems to replace and

streamline the number of simulations.¹ Nine years later there are still eight systems in use. One of the proposed three systems is still being developed. This is indicative of the problems identified in this study, redundancy and inefficiency.

The US Army's employment of wargames and simulations can be traced to back prior to the turn of the last century.² The Army's use of math based models and simulations began in earnest in World War II. Systemic operations analysis began with the Army Air Corps. This took the form of statistics analysis. While this concept had been employed in various capacities previously, World War II was the first concentrated effort by the Army to apply these methods in an attempt to improve operational procedures.³ The nature of air operations with regards to available aircraft, range and time limitations lent itself to this kind of numbers based approach.

Statistical analysis in the military became more common through the 1950s and 1960s. Mass data collection coupled with advances in mathematical modeling gained popularity in the Department of Defense as a whole throughout the late 1960s. Advances in computing technology made the application of this emerging capability to statistical analysis inevitable. The promise of math and computing were so influential that outside organizations such as the RAND corporation were hired to conduct additional research.

The first Army wargaming systems were map and board based. These involved rules constructs that regulated how to resolve combat between units in contact on the map or board and allowed for rapid decision making games. In the late 1970s computer programs were substituted

¹Brian Gates, "Army Simulations: Moving Towards Efficient Collective Training Sims" (Monograph, US Army School of Advanced Military Studies, 2002), 20.

²Captain W. R. Livermore, *The American Kriegspiel* (New York, Houghton, Mifflin and Company, 1879); Lieutenant Charles Totten's *Strategos: A Series of American Games of War Based upon Military Principles* (New York: D. Appleton and Company, 1880).

³Wayne P. Hughes, ed., *Military Modeling for Decision Makers* (Washington DC: Military Research Operations Society, 1997), 34.

to govern combat resolution that was depicted on the map or board. Eventually the algorithms that governed these simulations were programmed into fully computerized environments. By the 1980s the first fully computerized simulations for brigade, division and corps use were produced for the Army.⁴ These simulations relied on the computer to do everything from calculating battle outcomes to tracking units on a map contained within the simulation's program. While for ease training purposes there were often maps and boards to facilitate interaction between human participants, the migration to the digital realm was completed.

As the perceived benefit from models and simulations grew, the military kept attempting to refine its simulations in order to provide better training platforms for its members. This included systems for individual soldiers as well as vehicle crews and other smaller unit functions. The simulations with which this paper is primarily concerned are those which developed from the original brigade level wargame systems such as PEGASUS and FIRST BATTLE. The most recent evolutions of those systems include TACSIM and SPECTRUM.⁵ These systems are those that are employed by brigades and battalions and are those that funding is currently appropriated against. As will be discussed throughout the course of this paper, these systems were developed under guidelines which don't necessarily mesh with the Army's current training concepts. While they incorporate some measures, they often lack in developing critical and adaptable thinking in both terms of perception and performance parameters.

Currently development for all of the Army's simulations, from individual skills to vehicle crew to division and corps wargames, fall under the same umbrella organization, Program Executive Office for Simulation, Training and Implementation, or PEO-STRI. This organization

⁴Charles R. Shrader, *History of Operations Research in the United States Army*, vol. III (Washington, DC: Government Printing Office, 2009), 185-193.

⁵Gates, 20.

combines military officers, predominantly Functional Area 47, and civilian staff to oversee the Army's procurement and use of simulations. PEO-STRI also sets the parameters for what products are expected to accomplish, that is, what training objectives the various simulations are to meet when fielded. Though the organization is subdivided into various offices which handle specific categories, it is inherently inefficient to have the same organization responsible for quality control on simulations that are intended for use by a single person versus those designed to be a community experience. This has also begun to complicate the procurement of the next generation of computer models and simulations, as the current design parameters for these future programs stipulate that they be precise enough when modeling the environment and its effects that they can be used to development of physical equipment for future employment.⁶ While the idea to test physical equipment with computer modeling is laudable, it is a requirement that is unnecessarily complex for the staff training objectives required by the field Army.

The logic of having the same system for both training and testing equipment is sound from a financial and resource standpoint. If one system were developed for both training and testing it would save the cost of maintaining two separate computer systems. Alternative proposals must then demonstrate efficiency in cost or a substantial improvement in the training capabilities over the existing systems. The comparison of both cost and training potentials thus becomes a key metric in terms of this paper.

Training methods are addressed from the Army's standpoint of training requirements and how those requirements could be potentially be altered or met in a more efficient manner with other approaches. Education and training theory involving both individuals and organizations offers reasons to either emphasize or change some training requirements in order to better train

⁶Department of Defense Directive 5000.59, *DoD Modeling and Simulation (M&S) Management* (Washington, DC: Government Printing Office, 8 August 2007).

unit staff's in procedures and necessary functions. This is included to demonstrate that the Army's training goals are not adequately addressed in the development of the current generation of wargame simulations.

Of particular interest will be the effect an over reliance on technology may have on developing critical thinking skills and problem solving at the individual and group level. This may have a direct impact on the cost of systems if the need to rely on technological solutions is found to be unwarranted. While training with technology that is employed on the battlefield is necessary for all levels, relying on additional technology to enable that training incurs costs that are unnecessary. For example, while Command Post of the Future (CPOF) is used on the battlefield by commanders and staffs and should be practiced with in training, the cost of employing a separate program on additional computers is wasteful if alternative means to generate training scenarios are identified for brigades and battalions.

A brief overview of the historical development of wargames will be followed by discussing what the US Army believes are the necessary training requirements for Brigade and Battalion staffs. This discussion will include the US Army's procurement priorities and how they are supposed to support training requirements. Generally the Army's procurement model obtains materials necessary to conduct training. In the case of the simulations considered however there is strong evidence that training priorities as stated are not the preeminent guidelines utilized in procuring these systems. Contemporary learning theories are discussed to provide a frame of reference to support the idea that some of the Army's beliefs about training with simulations run counter to its own ideas. Alternative modeling systems are referenced, including some similar to those map and board systems from the 1970s as a means to reduce costs and meet the same amount of training requirements. This provides some financial comparisons to illustrate just how much the Army and Department of Defense have invested into models and simulations, often

repeating the same mistakes. Concluding will be suggestions for how to implement some of these changes at the unit level.

Are electronic simulations, wargames, providing the described training benefit to brigade and battalion staffs? With the current model of development stressing interoperability with Mission Command systems as opposed to prescribed Army training goals the benefit provided by the current simulations is in doubt. In line with this question, the Army's development procedures for models and simulations programs is examined. Other questions that directly impact how the Army utilizes its wargame simulations for training include: What does the Army require from its simulations for brigade and battalion staffs? Are these computer systems meeting the requirements at an acceptable price compared to alternatives?

The benefit of manual simulations has not been seriously considered by the US Army in over two decades. In a review of the most recent book published on the topic, Philip Sabin's *Simulating War*, a senior member of the US Army's Command and General Staff College history faculty notes, "it is somewhat surprising that so little has been written about how to use wargames."⁷ Sabin goes on to enumerate numerous examples of how to effectively design wargames for various training purposes and while not directly contrasting the expenditure of the US Army on computer simulations, does remark on the relatively low cost of such methods.⁸

Given the quagmire that is the US Army's annual budget costs for models and simulations can be found in by types of simulations being developed as opposed to specific

⁷Dr. Nicholas Murray, *Simulating War* in *Military Review* 93, no. 2 (March/April 2013): 111.

⁸Philip Sabin, *Simulating War* (New York: Continuum International, 2012), 19-21.

program costs.⁹ This is useful for the purposes of this analysis as it provides insight into how much the Army spends on these systems yearly, particularly in light of other research which compares how the end products are regarded by the units that utilized them in different years. The costs per year within the Army's budget can be specifically identified as those that aim at training brigades and battalions. The overall budget for simulations throughout the Department of Defense is estimated to have become nearly 6 billion dollars, within the Army specifically, over 600 million dollars annually.¹⁰

In this monograph training requirements are addressed through qualitative description of how various systems are utilized. This discussion will analyze the cost of systems and how units perceive their utility for different kinds of training. A key metric for this comparison is the perceived utility in the systems compared to their cost, e.g. whether the units using the systems, the "customers", believe the systems provide valuable training opportunities. In the course of this discussion the ability of various systems to be tailored for unit needs will be addressed. Included in this is the ability and frequency of units to run multiple iterations of training utilizing the same systems. While this kind of flexibility is sought in the development of most Army training systems the nature of how they are currently employed is often counterproductive to this principle.

The ultimate goal for training is to provide commanders with easily employable tools that they are able to utilize to train their staffs in a variety of situations without having to rely on technological systems that require additional specialists to employ. This would be best served by

⁹Department of Defense, *Research, Development, Test and Evaluation, Army (RDT&E)—Volume III, Budget Activity 6* (Washington, DC: Government Printing Office, March, 2104), <http://www.asafm.army.mil/offices/BU/BudgetMat.aspx?OfficeCode=1200> (accessed 1 March 2014).

¹⁰Charles Homans, "Wargames," *Foreign Policy* 188 (September/October 2011): 30.

systems that are readily employable with little outside support and with the knowledge of how to utilize those systems residing within the unit. Providing a common system for staffs to utilize would also strengthen the ability of units to communicate with one another, including in training. Additionally commanders should be able to run multiple iterations of training in a time sensitive environment without concern of having to reset or reprogram the system, which in many instances is not possible with the currently available systems.

HOW SIMULATION WARGAMING GOT TO THE PRESENT

The development of wargames can be traced back to the earliest forms of strategy games, such as “Go”, dating back to the 6th century BCE. More familiar in the west, chess is believed to have been developed from a game called “chaturanga” which originated in South Asia. Chaturanga spread both east and west, evolving into the modern versions of chess in the west and shogi and other games in the east. Though somewhat abstract in nature, these games display clear linkages with conflict of the times and show an appreciation for using systemic planning in order to be successful.¹¹

For this discussion, modern military wargames used for training begin with the German “Kriegspiel”. Developed originally in the late 1700s, variations on the game embedded themselves into Prussian training by the time of Von Moltke and the wars of German unification.¹² The establishment of the German Empire and the influence of the Prussian General Staff within it only served to increase the reputation of this kind of simulation. Utilizing the Kriegspiel the Great General Staff tested new ideas in their planning without regard of training cost. This system also enabled repetition to ensure familiarity throughout the Army. It was

¹¹Alfred Hausrath, *Venture Simulation* (New York: McGraw Hill, 1971), 3-5.

¹²John Prados, *Pentagon Games* (New York: Harper Row, 1987), 5.

Kriegspiel that allowed successive generations of the German General Staff to plan successful campaigns through the opening of the First World War.¹³

The influence of Prussian military thought throughout the world is apparent in history with the adoption of forms of Kriegspiel by various militaries around the world. Japan adopted a form of Kriegspiel, and, while its Army trained its new officer corps with it at the turn of the 20th century, it was Japan's Navy that used wargames to see its way through a successful war with Russia and plan for the conflict with the United States. Tsarist Russia was aware of the Prussian tradition but it was not until its shocking loss to Japan in 1905 that Russia displayed interest in the technique. By 1914 Russia had utilized its own form of Kriegspiel to identify flaws in their war plans with Germany. The recommendations to correct the identified problems were not adopted by the Russian field command. These same flaws were then later exploited by the Germans at Tannenburg.¹⁴ Even Germany's most ardent rival France saw utility in the method, Jules von Verdy Vernois publishing "A Simplified War Game" in that country in 1876.¹⁵ As 1879 there was debate within the US Army whether to adopt a version of the German Kriegspiel or to refine systems that were being developed domestically by junior officers aware of the Prussian simulation.¹⁶

What made the Kriegspiel so useful to the Prussians and influenced the development of simulations in the modern military tradition? Simply put, it facilitated participants' ability to conduct frequent repetitions of whatever processes wished to be exercised by the Army utilizing the construct. Given a logical set of rules and a resolution matrix to provide results when some

¹³Peter Perla, *The Art of Wargaming* (Annapolis: Naval Institute Press, 1990), 28.

¹⁴Hausrath, 24.

¹⁵Perla, *The Art of Wargaming*, 31-32.

¹⁶Livermore, *The American Kriegspiel*; Totten, *Strategos*.

conflict occurred between opposing forces allowed these groups, predominantly staff officers with commanders participating, to practice their tasks through multiple iterations without having to actually deploy troops or actually fight a battle. While some saw this as devolving into imprudent prediction of actual combat, others realized that the real advantage was in giving officers practice in executing the tasks they would be expected to perform without having to have an actual conflict occur.

This was put to great effect by the German Great General Staff with the nearly legendary tables of train movements in order to facilitate large scale troop movements. The actual results of combat were not so much the focus as the ability to perform one's staff function with realistic information being provided that could change over time to forces staffs to adapt. As the techniques for wargaming spread, other nations utilized them to similar effect.

Japan's Imperial Navy adopted wargaming earlier than its Army. In turn, the success against Russia in 1905 and the early victories over US forces in World War II are directly attributed to the Naval Staff's ability to conduct wargames of realistic scenarios. Conversely, when it was observed that those responsible for running the games made arbitrary rulings against what many officers saw as realistic, disasters resulted such as the loss of four aircraft carriers at the Battle of Midway.¹⁷ The effect of the overwhelming success of the Pearl Harbor raid resulted in increased US interest in how the operation was prepared, to include the aspect of wargaming.¹⁸

The US Navy adopted techniques that essentially were variations of wargames as early as the late nineteenth century and continuing through the interwar period into World War II. Under the first President Roosevelt the Naval War College conducted studies in support of his corollary

¹⁷Perla, *The Art of Wargaming*, 45-47.

¹⁸Gordon W. Prange, *At Dawn We Slept* (New York: McGraw Hill, 1981), 47-53.

to the Monroe Doctrine. These involved maps, charts and chance (e.g. dice) to determine the ability of the Imperial German Navy to conduct operations in South American waters.¹⁹ In the interwar period the Navy continuously used a scenario with a fictitious stand in for Japan referred to as “Orange.” This scenario was used in so many training exercises by the Naval War College and the Pacific Fleet that the resultant overall plan the US Navy followed has come to be referred to as “Plan Orange,” by historians. Admiral Nimitz later remarked “nothing that happened in the war was a surprise except the kamikazes.”²⁰ In the early period of the war the Massachusetts Institute of Technology assisted the US Navy in establishing the Antisubmarine Warfare Operations Research Group (ASWORG). This group used analysis of German submarine attacks in order to develop naval and air tactics to effectively combat the threat. They were able to test their hypothesis as a model and simulation, effectively a wargame, to determine which allied vessels and aircraft would be best suited for conducting these innovative tactics. By 1943 German submarine attacks had been reduced significantly. The hidden benefit of this analysis was manifested in a considerable reduction in flight time, which produced great savings in fuel and maintenance on aircraft.²¹

Ironically Germany itself placed less emphasis on its traditional Kriegspiel than other combatants during World War II owing to the erratic effect Hitler’s regime had on the German General Staff. Though not widely used for operational decisions it remained a well regarded training tool in all branches of the third reich’s military. After the war’s end, the perceived effectiveness of German military staffs increased interest in the system as a training tool.

¹⁹Edmund Morris, *Theodore Rex* (New York: Random House, 2001), 180-181.

²⁰John B. Hattendorf, *Sailors and Scholars* (Newport: Naval War College Press, 1984), 127.

²¹Perla, *The Art of Wargaming*, 106-112.

The rise of the RAND Corporation's influence in the US Defense establishment in the 1950's brought more quantitative methods to the established practice of wargames.²² Despite the amount of research generated by educational institutions involved with various Department of Defense groups, the first general study of wargaming, or professional military simulation, was published in 1957 by Francis McHugh of the Naval War College.²³ This work represented the first to attempt to fuse the principles of wargames, what they could be used for and the contemporary desire to efficiently model systems with numbers and math. This work is still referenced today by the US Navy. Despite the Army and Air Force's interest in quantitative models and simulations, the next comprehensive study of wargames came from the private sector.

In 1954 Charles Roberts, a former Army reserve officer from Maryland, published "Tactics." This would be the first game of the Avalon Hill Company, which still produces wargames and associated products to this day. Roberts' rule set and analysis were noticed by the RAND Corporation, and his model of a Combat Results Table (CRT) was adopted by Rand. This was one of the first forms of combat resolution matrix that did not strictly adhere to a numerical comparison of perceived weapons values. The advantage in this was it allowed for interactive results, as results could be generated with regards to decisions the players made with regard to actions, as opposed to merely how many forces, and therefore weapons values, were present at a conflict.

²²Alex Abella, *Soldiers of Reason* (New York: Harcourt Inc, 2008), 34-35. This history of the RAND corporation also describes RAND's interest in wargaming, beginning with reviving the German Kriegspiel in the 1950s.

²³Francis McHugh, *Fundamentals of Wargaming* (Newport: Naval War College Press, 1957). The remainder of the references in this paper to this book will refer to the third edition, published 1966.

The Combat Results Table caused RAND's interest, as this manner of resolving competitive decisions appealed to the burgeoning study of non-perfect information games. A "non-perfect information game" is the description applied to a game or simulation where all competitors do not have a complete picture of information as to what options are available to an opponent. This stands in contrast to a game such as chess, where the entire board is always visible and all pieces are visible to all parties. While most wargames such as Kriegspiel only revealed a portion of the enemy's forces to adversaries, they did not incorporate a method to resolve competing decisions, only taking into consideration a ratio of forces that were present in the same location, e.g. comparing weapons values. With the CRT a game was able to provide a range of probability of outcome based on the decisions of both players made simultaneously. This is a much better replication of decisions made during conflict and war, as leaders often must make the best decision possible without having all information available while an enemy does the same.

This seemingly simple concept was adopted just as computer processing capability increased to a level appropriate to calculate such probabilities with unparalleled accuracy and speed. It is still a concept employed when designing wargames for both commercial and for military use. As Avalon Hill and other companies continued to refine their products with historical research for sales purposes, the Pentagon continued looking towards the computer's potential to recreate battlefields for use in training. The appointment of Secretary McNamara in the 1960's reinforced the idea of exhaustive quantitative analysis, which helped drive computer investment.²⁴ The Navy continued its use of wargames as the nature of combat at sea lent itself to comparing measurable data, such as the speed and direction of newly developed missile weapon systems compared to the speed and resilience of a target. This type of data had already been

²⁴H. R. McMaster, *Dereliction of Duty* (New York: Harper Collins, 1997), 62.

quantified through test procedures in live experiments and thus was well suited to quantitative comparison.²⁵ Computers made these kinds of comparisons with great speed and accuracy. Likewise, the Air Force's focus on technology and systems led to more investment into institutions such as RAND for computer simulation using mathematical models. This infatuation with the computer's potential carries through into contemporary development priorities.

The US Army first purchased a tabletop wargame designed for commercial purposes in 1976. "Firefight" by Simulations Publications Incorporated (SPI) was thought to be useful for tactical training and experimentation. In the post Vietnam era of constrained spending, the low cost commercially produced game was a useful alternative to other potential methods of training aids.²⁶ Another system developed by Armor officers Hilton Dunn and Stephen Kempf, known as "Dunn-Kempf," was well received and continued to be utilized until the late 1980s. However the ever present undercurrent of belief in the inherent superiority of computer based systems led knowledge of these systems to atrophy. As late as 2001 at Fort Knox, there were fiberglass boards originally meant for Dunn-Kempf use which were utilized for map reading classes, the majority of the instructors not realizing what the boards were originally meant to be used for.

Thus since the late 1980s there has been almost no sponsored research by the US Army into any form of decision making game, or manual simulation, at the brigade levels as the preference for computer based systems grew. Systems such as JANUS, BBS and WARSIM were developed and utilized to train tactical and operational level maneuvers with participants

²⁵There are numerous data sets in the forms of old weapons tests available for this type of comparison. Many Naval weapon systems were tested against known materials, and thus realistic and applicable results could be reported with regards to the survivability of particular vehicles when struck by particular weapon systems. Data of this sort is essential to Entity Resolution Federation based systems, described later in the text.

²⁶James Dunnigan, *The Complete Wargames Handbook*, Revised Edition (New York: William, Morrow and Co., 1992), 242-243.

generally fixated on a computer screen. Army Simulations evolved into a necessary functional area in order to keep pace with development. This simulations branch was given the responsibility for overseeing all simulations use, from individual systems, such as the WEAPONER M-16 rifle simulator, to those simulations accounting for Corps and JTF level exercises. While this was an attempt to ensure oversight in the development of simulations programs it did not include operations systems as they developed such as Blue Force Tracker or Command Post of the Future. This caused problems when programs attempted to communicate with one another as the programming standards differed between systems, often necessitating the development of additional software modules to facilitate simulations being able to share information with the electronic operations systems used in command posts to oversee operations. These systems are contemporarily referred to as Mission Command Systems.²⁷

Mission Command systems are those systems found in a unit headquarters which enable the commander and the staff to accurately receive and display information. Technically this could include everything from the radios to the paper maps that inhabit most unit headquarters. Specifically they are used to describe the computer systems which modern units use to accomplish these information functions. Systems such as Command Post of the Future (CPOF), Blue Force Tracker (BFT), Army Field Artillery Tactical Data System (AFATDS) and others are used to display and communicate information between units and their headquarters. These systems have found themselves at the center of much of the development process for simulations, despite the fact that they were originally not developed for training purposes. The Army has

²⁷Not particularly long ago, Mission Command systems were referred to as “Command and Control” systems, the systems haven’t changed as the ones currently in use were developed when the term was still Command and Control. With the Army’s relabeling of everything that was Command and Control to Mission Command, the systems are now referred to as such. Adding to the confusion is that Joint Doctrine still refers to this concept (and in turn, the systems) as Command and Control.

determined that simulations which effectively communicate with all of the various systems will best serve as training tools for its units.

DIFFERENCES IN TRAINING GOALS AND SIMULATIONS PROCUREMENT

The Army uses the following definitions for types of training in a broad category: Live, Virtual and Constructive. Though generally used in conjunction with modeling and simulations, nearly all Army training can be categorized into one of these categories. Live training encompasses any activity that is physically performed as it would be done under field conditions. Obvious examples of this would include weapons training where a soldier or service member actively fires live ammunition on a range. Field exercises are also included in this type of training, whether they involve large vehicles moving cross country or the battle staff executing their duties from a tent supported by electrical generators. Virtual training is conducted entirely in a simulated environment, most often in modern training on some sort of digital network, e.g. computers. The term Virtual implies that all of the information for the exercise, whether the information represents material or people, only exists as information in either a digital form or recorded in some fashion. Constructive training is the combination of the two. Many otherwise Live training events are constructive on some level due to the integration of multiple units in other forms. Examples could include a brigade combat team that has one maneuver battalion conducting field exercises and two battalions only maneuvering on a digital map but providing reports to both the brigade headquarters and the battalion in the field to replicate the experience of a larger operation.²⁸

²⁸DoD Directive 5000.59; David Neyland, *Virtual Combat* (Mechanicsburg, PA: Stackpole), 6-10. This “Live, Virtual, Constructive,” methodology is found repeatedly in both DoD and Army publications.

The Army's expectation for training staff officers at Brigade and Battalion level is specific in some regards and ambiguous in others. In some manuals or regulations duties are specified for staff positions in terms of what information is required and in some cases in what format it is expected. In other cases it is left vague or utilizes the term "at the discretion of the commander."²⁹ This lack of specificity is intentional and in many cases desirable, however, for designing a system to train a coherent staff in a fashion that can be automated it is far from ideal. It is precisely this lack of a universal or cohesive idea for how a brigade or battalion battle staff should operate that prevents an automated system from meeting every requirement. Every commander will have his own opinion on how their staff should operate, thus, training methodology needs to be able to adapt and quickly change depending on what the chain of command deems relevant for their respective staffs.

This idea runs against the Army's traditional training methodology which relies on clearly defined tasks and standards.³⁰ Implicit in the language that ADP 7-0 uses is deference to the commander's ability to determine what he feels the unit or staff's priorities should be. This creates problems for procuring systems that attempt to address the training standards for personnel with disparate duties, such as those found on a battle staff. The Army feels that recreating the information flow that would enable battle staff's to train without actually conducting combat operations requires computer simulations. However, the requirement to meet multiple sets of standards that cover the entire spectrum of battle staff positions makes this move from the realm of complicated number crunching to a complex balance of disparate systems and requirements.

²⁹Department of the Army, Army Doctrine Publication (ADP) 7-0, *Army Electronic Publications and Forms* (Washington, DC: Government Printing Office, 2012), 6.

³⁰*Ibid.*

Table 1. The Army Principles of Unit Training

Table 2-1. The Army principles of unit training

• Commanders and other leaders are responsible for training. • Noncommissioned officers train individuals, crews, and small teams. • Train to standard. • Train as you will fight. • Train while operating. • Train fundamentals first. • Train to develop adaptability. • Understand the operational environment. • Train to sustain. • Train to maintain. • Conduct multiechelon and concurrent training.

Source: ADRP 7-0, 2-1.

The principles listed in the table above are supposed to support how training is designed and thus how materials for such training are procured. The fourth principle, train as you fight, is used as justification for the emphasis on technological development. The competing ideas between commander's preferences and the desire for Mission Command systems to interface properly with simulations have been decided in favor of automated technology. This is now the predominant factor for how the Army procures these systems.³¹ The attempt to integrate disparate automated standards has complicated procurement and led to training outcomes to become a secondary consideration for simulations software and hardware. Additionally, a key component of current requirements insist that modern Mission Command systems are able to interface with these simulations. While on the surface this would support the Army's training philosophy of

³¹U.S. Army, *PEO-STRI Desk-Side Reference Guide* (Rockville, IL: KMI Media, 2013). This publication lists the current and proposed systems that PEO-STRI is currently overseeing. Replete in descriptions of the programs are terms which describe the capabilities of these systems to interface with other programs and Mission Command equipment. While there are training objectives referenced, the technological capabilities outnumber the training objectives listed. Only one of the systems described for the echelons considered, Army Low Overhead Training Toolkit (ALOTT), describes its capabilities predominantly as training based outcomes.

“train as you fight,” it adds considerably to cost and time in procuring these programs as many Mission Command systems are not compatible in terms of programming data and interface. At times this even requires additional programs or hardware to be developed to act as a “translator” between Mission Command systems.³² The focus of these types of requirements would seem to emphasize the Mission Command hardware as opposed to the understanding and execution of duties by commanders and their staffs.

Unit commander’s understand this and implement training they feel is relevant to their organizations. However this raises the question of why does the Army dedicate vast sums of money to developing systems that get bogged down in development considerations? Further, it begs the question, why is the training focus not on understanding requirements and the execution of duties? This is generally the focus of commander driven training as alluded to earlier as commanders attempt to ensure their staffs understand how to operate effectively. The emphasis the Army has placed on developing training systems to operate with contemporary Mission Command systems effects the entire development process. Instead of training skills and tasks being the primary requirement, ensuring Mission Command systems to communicate and manipulate has become the key parameter in procurement for Models and Simulation.

But what of the other principles in ADRP 7-0? Train fundamentals first. Would not manual systems using maps be a fundamental? Train to develop adaptability. Learning systems to enable exercise would encourage adaptability, as just simple changes in circumstances such as where to set up data displays would necessitate adaptability. These have seemingly been pushed

³²Thomas Held, Bruce Newsome and Matthew Lewis, *Commonality in Military Equipment* (Santa Monica: RAND, 2008). It should be noted this has been identified as a concern for both Army and DoD procurement as outlined by Held, Newsome and Lewis. It is telling that their study was published in 2008 but the issue still remains.

aside as “train as you fight” has been interpreted to justify a technological imperative in training procurement.

In order to appreciate the full impact of these competing requirements on the development cycle, a brief description of the current Army procurement system works is necessary. The key aspect to understand is that the Army uses the production term “Key Performance Parameter” (KPP) to govern the development and procurement of any system.³³ These KPPs nest within the larger construct of project milestones. Project milestones are those objectives which must be met by a systems as they move through the steps of defense acquisitions.³⁴ Taken in conjunction with the previously referenced emphasis on electronic systems the Key Performance Parameters for Models and Simulations often include things that have nothing to do with the execution of staff duties or training tasks. Rather KPPs are expressed in terms of how a simulation will interact with a Mission Command system such as Command Post of the Future (CPOF) or the Global Positioning System. These requirements then cascade throughout the development process, requiring computer simulations running one program be able to communicate with systems developed on entirely different programming paradigms. Often lost in this labyrinthine method of development is the original military purpose of training.

Integral to the requirement for wargames simulations to interact with the various automated systems found in the modern headquarters is requirement for the program to provide information which can be displayed by all Mission Command systems. The stated intent of PEO-

³³Chairman of the Joint Chiefs Staff Instruction 3170.01 H, *Joint Capabilities Integration and Development System* (Washington, DC: Government Printing Office, 10 January 2012).

³⁴David S. Sorenson, *The Process and Politics of Defense Acquisition* (Westport: Praeger Security, 2009), 55. The steps currently described are Concept refinement, Technology development, System development and demonstration, Production and Deployment, and Operations and Support.

STRI is create a fully immersive experience where a single program determines the course of a fictitious battle which then stimulates the various Mission Command systems so that a unit may exercise its staff functions. This idea is laudable but doesn't consider the manner in which the Army has acquired its various systems. The Army has acquired its current generation of Mission Command systems without ensuring the systems utilize common standards of programming. This causes additional requirements for any proposed simulation program mandating that it can communicate with each Mission Command system. The requirement to ensure this communication results in testing the proposed simulations against each system separately and then collectively, further adding to cost and time in development. The Army's National Simulation Center has acknowledged this issue and is attempting to ensure the development for the next generation of systems are designed with common information standards but presently systems are still in development taking dollars and time to meet this competing and at time contradictory requirements.

Further evidence of the dysfunction in the system is the Army's history in simulation development. In 2002 the Army possessed ten simulations systems and programs that covered a spectrum of conflict from the Corps echelon and higher down to the battalion level. The plan in 2002 was to replace these systems with three new systems, one for division and above, one for brigade level and some battalion functions, and one for battalion and below which would streamline use and procurement.³⁵ This was to be implemented by 2007. As of 2014 however, there are still ten systems in place.³⁶ Perhaps a greater example of ballooning cost is that not only

³⁵Gates, 12-20.

³⁶U.S. Army, *PEO-STRI Desk-side Reference*. PEO-STRI is the US Army office responsible for developing Models and Simulations.

are there still ten systems being used, several of which actually replaced the old systems without any of the planned consolidation occurring.

Another facet of the Army's simulation development that has frustrated development towards unified systems is the difference in what the military wants its battle simulations to consider based on the different echelons of training. Within the Army's construct of strategic, operational and tactical level warfare, simulation programming has coalesced around two concepts, "Entity Resolution Federation," and "Multi Resolution Federation." What these programming concepts represent are how different simulation programs interpret information. Inherent in the discussion is the fact that simulation programs must use one concept or the other, attempts to utilize both lead to additional programming requirements to get the computer algorithm to properly interface. This adds additional complexity to the already confusing development requirements.³⁷

Entity Resolution Federation (ERF) programming represents the various things represented in the digital simulation world individually. This is to say that every vehicle in a unit represented will have its own associated information. Furthermore, ERF systems account for weapon systems individually and treat them as if they are separate objects within the simulation. For example, in an ERF simulation, a plane or tank has a given information value which includes location, direction and speed at a minimum to represent that object in the simulation. Often objects require additional information such as number of times an object may fire its weapons systems, how many weapon systems, etc. Carrying this logic through, each time the object fires a weapon system, such as the plane firing a missile, the projectile becomes a separate entity within

³⁷Mikel Petty, Robert Franceschini and James Panagos, "Multi-Resolution Combat Modeling," in *Engineering Principles of Combat Modeling and Distributed Simulation*, ed. Andreas Tolk (Hoboken: John Wiley, 2012), 608.

the simulation to be accounted for. The projectile missile has its own location, direction and speed at a minimum represented in the simulation until it reaches its target, at which point other information will be compared, likely the resiliency of the target against the destructive potential of the projectile, and the computer will adjudicate results which then get represented in the simulation.

ERF simulations are preferred for simulations dealing with individual skills or small unit training. They are information intensive, though as computing power continues to grow exponentially and becomes smaller, this has become less of a concern. The Close Combat Tactical Trainer (CCTT) was regarded as one of the previous pinnacles of ERF based programming, as it can represent individual vehicles which are controlled by soldiers in training mock ups represented as individual objects within a larger simulation construct, which can then incorporate other completely simulated entities both friendly and enemy to replicate engagements up to brigade level while providing individual training for over one hundred soldiers.³⁸

Multi Resolution Federation (MRF) programs follow a different approach. Within MRF simulations entities do not represent individual vehicles and weapons systems, but rather entities are an aggregate of associated constituent elements. What this means is that an entity in the simulation represents some unit and does not account for each subordinate element in the unit individually. Thus a unit will have the minimum required location, direction and speed along with other relevant information as a shared value. While this makes programming for larger scale

³⁸The Close Combat Tactical Simulator (CCTT), which can facilitate upwards of 50 crews in vehicle simulators as individual entities firing multiple weapon systems within a shared simulation, initially required nearly 2000 square feet of space to house the necessary computers to govern all of the information requirements when it was fielded in 1993. The current upgrades to the CCTT as of 2007 allow the same level of fidelity while requiring only a dozen or so computers acting in conjunction.

simulations easier, as the computing power is lessened due to the lower amount of information, it does not allow fidelity at the individual level.

The two programming concepts of ERF and MRF are difficult to reconcile. An ERF based system can represent a unit by totaling the number of entities in the same location as a single unit, but it will still resolve their actions within the simulation individually. That is, a company of 14 tanks can be represented by a single icon on a display, but the program will still track 14 entities and resolve their fire individually. Conversely, an MRF based system could be programmed to divide the unit aggregate capability by the number of units in an entity. Again using the example of a tank company this would be accomplished by dividing the company entity by 14, but this will result in the simulation treating the 14 separate entities as units which contain the equivalent capability of one fourteenth of the information value of the tank company, as opposed to accounting for them as individual vehicles within the simulation.

This adds confusion to the Army's ability to develop systems which can cross multiple echelons as well as different Mission Command Systems. Some programs are ERF based, generally those at brigade and below, such as JANUS or the program which controls the CCTT, while many higher echelon programs like WARSIM are MRF based³⁹. When designing contemporary simulations that will be able to pass information between systems which are already extant it requires parallel development of software to "translate" between the differing programming standards. Thus due to the nature of the Army's development process, there are instances when proposed simulations must pass two communications filters. The first to reconcile communication with Mission Command systems, then a second to facilitate information exchange between programs handling different levels of a conflict.

³⁹U.S. Army, *PEO-STRI Desk-Side Reference Guide*, 32.

In its efforts to develop systems which meet ever expanding requirements that are not always focused training purposes, the Army has several simulations fielded. While most are useful in some context, few manage to speak to multiple Mission Command systems or are require the unit training to remain static in a building location. Additionally there has not always been effective dissemination of training methodology, forcing the retention of dedicated experts to make simulation training efficient at every level. This observation has not changed significantly in twenty years, as reports from both 1993 and 2013 make similar points.⁴⁰

At the Brigade level and below, is it necessary for a simulation system to automate every conceivable aspect of modern warfare in order to train its staff and subordinate units? This basic question is assumed to be Yes from a program procurement standpoint. This attitude compels the simulations developers to account for an exhaustive list of potential outcomes in a simulated environment. It also feeds into the cycle of having the simulation communicate these results to each Mission Command system. Such an attitude leaves little room for creativity in training. Designing such a system at any level has proven difficult when considered discretely and only increasingly problematic when attempting to communicate across various programming standards. This attitude is not universally held however, as other research holds that simulations which do not model every facet of an environment still produce quality educational and training opportunities.⁴¹

⁴⁰Government Accounting Office, “Army Training: Commanders Lack Guidance and Training for Effective Use of Simulations,” GAO Report (Washington, DC: Government Printing Office, 1993).

⁴¹Nancy J. Cooke and Stephen M. Fiore, “Cognitive Science-Based Principles for the Design and Delivery of Training,” in *Learning, Training and Development in Organizations*, ed. Steven Kozlowski and Eduardo Salas (New York: Routledge, 2009): 184-187.

Is such a system necessary then? Are there other methods of achieving the same training functions? The Army's standpoint seems to be that only computer modeling and simulation offers an acceptable solution. This is reinforced by the fact that, while the Army used to sponsor research into decision making games as simulations for training through the 1980s, there has been no Army level discussion regarding the topic since computer simulations came to be regarded as the solution for these training issues in 1993.⁴² The last research conducted by an official Army office into such methods was in 1985.⁴³

These symptoms are all facets of the Army's belief that computer simulation is and will continue to be the most effective tool for training in lieu of live exercises at all levels. The Army has invested much in this line of thought- upwards of 600 million dollars annually since the early 2000's.⁴⁴ While computer modeling and simulation offer a great deal of potential, the roadblocks emplaced by the Army's own organization have continuously delayed such grandiose visions from evolving into useful systems. Instead simulations have progressed haphazardly, as good ideas get bogged down attempting to meet KPPs influenced by competing and often contradictory demands.

Would units not be better served by a system that met a standard set of training criteria for its users? The standard training criteria already exist, the Army has been conscientious about

⁴²Neyland, *Virtual Combat*, 1-4. While computers had been used by other branches of the military and at higher echelons in the Army, with the development of SIMNET, fully integrated use of simulations to support Brigade and below training became feasible.

⁴³David Bessemer and Donald Lampton, "Development of TRAX-I: A Tank Platoon Game Modifying Dunn-Kempf" US Army Research Institute for the Behavioral and Social Sciences report (Washington, DC: Government Printing Office, 1985). While articles in professional journals and research papers have been published as studies at various military schools, this is the last sponsored and accepted report on an "analog" or tabletop gaming system for the Brigade level and below by an Army research agency.

⁴⁴Homans, "Wargames," 30.

publishing through field manuals and other training publications what duties and functions units should expect from their staffs and constituent units. Commander's use these training criteria as guidelines when they develop their training plans to ensure units are prepared to deploy in support of potential missions. Ensuring the systems that are used at Brigade and below utilize these training criteria as their development guidelines would seem a logical extension of the use of simulations.

What is occurring however is that technological considerations are being given priority when developing models and simulations. The assumption that Mission Command systems must be utilized in order to conduct proper training for the commanders and staffs is cited as the justification for this line of thought. In turn this assumption is based off the idea that all that is required to effectively conduct their duties is familiarization and practice with the Mission Command systems. There are numerous legitimate reasons for this reasoning foremost being the efficiency of the Army educational system ensuring soldiers assigned to units are competent at their particular roles. In practice this attitude results in programs which confuses understanding how to operate the Mission Command system as opposed to displaying proficiency in assigned tasks. The difference in this attitude may seem small but potentially has long term implications in the development of soldiers.

The Army's stated goal is to produce adaptive soldiers and leaders. This laudable objective is not easily quantified, however many would agree a key facet of "adaptability" is the ability to conduct operations in situations which may not include the conveniences taken for granted in a computer generated simulation. The Mission Command systems may not be available due to electrical constraints. Or the situation may not lend itself to their productive use, such as coordinating indirect fire between allied forces. There are any number of reasons why being proficient with Mission Command systems may not ensure the ability to conduct operations in a field environment. These are often dismissed as contingency considerations at best, but in an age

where US Army Brigade Combat Teams find themselves reporting to German Division Headquarters in a NATO task force, these contingencies should not be so easily brushed aside.⁴⁵

These issues lead to the realization that despite the best efforts of the people assigned to the byzantine conglomeration of organizations, many of the Army's guidelines and practices contradict themselves in some very basic ways. In the belief that simulations will lead to cheaper alternatives to live training, the Army has averaged spending 600 million dollars a year on computer simulations.⁴⁶ Discounting systems focused on individuals or vehicle crews, such as flight simulators or small arms simulations, nearly 100 million annually is spent on either maintaining or developing systems that directly impact training at the Brigade level or below. While this may be a small number in the grander US Defense budget, the cost of sending a Brigade to the National Training Center at Fort Irwin for a live training rotation is between 10 and 25 million dollars⁴⁷. In order to save money, the Army is spending enough to send four Brigades to live training, acknowledged to be the best preparation for deployment, in an effort to develop simulations that replicate something similar. What makes this comparison particularly striking is that, as previously stated, after all of the years of investing this amount of money, the Army still does not have a comprehensive simulation for the very types of brigades that the deployment infrastructure is based around.

The perceived effectiveness of the simulations provided to the force support the lack of a comprehensive simulation at this level. GAO, RAND and academic surveys covering a span of

⁴⁵In Afghanistan in 2011, Regional Command-North was led by a German Division headquarters. In addition to a US Brigade Combat Team and its own Bundeswehr subordinate units, it was responsible for coordinating military units from over 20 NATO member states and other allies.

⁴⁶Department of Defense, *Research, Development, Test and Evaluation*.

⁴⁷Nomination for Secretary of Defense Environmental Awards, Pollution Prevention, Non-Industrial Installation, 2002.

time from 1993 to 2013 display a lack of belief by field commanders in the utility of many of the training simulations provided by the Army. Additionally, they find there is often a significant difference between how the simulations operators view their capabilities and the perception of the unit customers. This statement is supported by the Army's own research, as one study in 2013 found that 90 percent of infrastructure personnel, those who operate and support the simulations, believed they provided adequate or better training opportunities, while only 45 percent of commanders and staffs rated the same capabilities that highly. This study included multiple Army posts in its surveys.⁴⁸

Would a system other than computer models and simulations offer similar or potentially better capabilities at reduced cost? This question has not been seriously considered by the Army since the late 1980s. With budgets shrinking perhaps questioning the cost and utility of the computer based systems is overdue. Some have obvious advantages while others seem to be circumspect in their ability to enable the education that the Army states as goals. The relative measure of whether it is cheaper and safer to conduct hundreds of hours in a helicopter flight simulator versus the expenditure of fuel and resources to allow the same number of hours on an actual airframe is quantifiable. Whether or not a Brigade staff is able to make timely, critical analysis while experiencing changing situations is not as straightforward a calculation, though the Army's dedication of funds seems to equate the two concepts.

BETTER ENABLING COLLECTIVE TRAINING GOALS

The development requirements for these model and simulation programs are often centered on technical issues. But the question of how people incorporate new knowledge is not

⁴⁸Government Accounting Office, "Army Training : Commanders Lack Guidance and Training for Effective Use of Simulations," GAO Report (1993); Mark Riecken, Johnny Powers, et.al., "The Value of Simulation in Army Training," presented at Interservice/Industry Training, Simulation and Education Conference (I/ITSEC) 2013.

addressed. It is assumed that if the programs meet the development requirements then they will by default meet the desired training objectives, as they are at the root of the development requirements, even when buried beneath technical aspects. At least, this is the theory. Upon closer examination, there are few training requirements listed as those all powerful development terms key performance parameters. In many respects the Army has conflated exercising electronic information systems with training.

How do people learn and incorporate new knowledge? This question has been considered by the Army in other areas. There are a multitude of Army reports and studies discussing the most efficient methods of training groups of people to a standard. There are also numerous civilian studies on adult education. Yet there is little acknowledgement of these considerations in the guidelines for developing these simulation programs aside from an inherent understanding the repetition is a key to training and computer simulations can provide repetition at greater frequency for lower cost.

The Army's default position since the late 1980s has been that computer technology is the best manner in which to train soldiers apart from live environments. Significant financial investment continues to be made to further computer based programs. This belief is often true in cases where simulations can be designed to specifically mimic tasks that individual soldiers must be proficient at. In these cases, simulations are cheaper than sending soldiers and material out to training areas. These programs take advantage of repetition, one of the basic building blocks of human learning. Thus it follows that repetition is also useful for training groups of people how to react to situations best as a group. This is effectively why battle drills are a useful method of training units and staffs. By repeating the same actions in response to outside stimulus, groups or units understand through repetition what is expected of them in a particular situation. Computer simulations are able to provide this level of realism as well. The Army's contemporary issue is in how Mission Command systems are integrated into such training.

As alluded to previously, most Mission Command systems currently fielded were developed without regard for one another. Thus when simulations are developed to be able to provide information to all of them simultaneously it leads to the problems of developing sub-systems which can enable the programs to communicate with one another properly. This has not been completely resolved, and thus training with computer simulations often fall short in different ways. Programs that only talk to some of the Mission Command systems disrupt the capability of the entire group to work together. Other programs which can accommodate the majority of systems offer only a limited scope of potential battlefield environments. No current program can currently effectively communicate with every Mission Command system. While they offer a measure of repetition, due to their current inflexibility, they ignore another key aspect of unit training, adapting for changing situations. There is also no discussion of whether or not the Mission Command Systems are best for training service members to understand their duties in contrast to teaching them how to manipulate the electronic system. Understanding should be the goal as it would lead to the flexibility and adaptability the Army claims to desire.

How do groups learn to adapt to a fluid and evolving situation? Again repetition is useful, but only if the systems utilized are capable of changing the simulated environment rapidly. While computers can accomplish this, under the current construct of simulations development this process is difficult and often time consuming with the current generation of simulations when attempting to train a Brigade staff. A great deal of preparation is required for simulations to be used in this manner and there are often still shortfalls when attempting to change scenarios “mid-stride.” This leads to difficulty in conducting a training event where a group attains a level conducive for true learning in an adaptive environment, where experiences build upon one another as the scenario changes. Additionally, since the simulations are focused around displaying information on the available Mission Command systems, in some respects they are counterproductive to encouraging adaptability.

While computer automation is often found to be cost effective when seeking methods to reduce expenditures, the manner in which they are employed in Army wargame simulations is often constrictive. When used, computers should enable “knowledge construction” as opposed to “knowledge reproduction”.⁴⁹ With the simulation being used to drive the mission command systems display of information, a key advantage of the computer system is lost. However as the Key Performance Parameter of the development likely centered around the ability of the simulation to communicate information to the Mission Command system, this instance of information being displayed would likely be considered a success. If critical thinking came from a group of people in a room each centered on their own individual display panels, this may very well be the epitome of wargames simulation design. Or rather, if all that a commander required was an environment of “perfect information” from which to decide upon a proper course of action were required, this would be a logical approach to training. The Army, correctly, has determined however that this is not how conflicts are conducted, nor should commanders expect to have “perfect information”.⁵⁰

There are both civilian and military studies into methods that are effective at training groups. Many of these focus on how to train large numbers of people to perform individual tasks in a group setting. In these types of circumstances, computer automation is a valuable method of providing more opportunities for those being trained, particularly at lower cost with regard to repetition. Good examples of this are found in the current generation of small arms simulations

⁴⁹David H. Jonassen, Chad Carr, Hsiu-Ping Yueh, “Computers as Mindtools for Engaging Critical Thinkers,” *TechTrends* 43, no. 2 (March 1998): 24-32: 29.

⁵⁰Department of the Army, Army Doctrine and Training Publications (ADRP) 5-0, *The Operations Process* (Washington, DC: Government Printing Office, 2012). Chapter 2 is the latest presentation of Army planning doctrine which makes clear the necessity for assumptions, risk and assessment based off not being able to be omniscient on in any environment.

which allow soldiers to practice engaging targets in differing environments in a realistic manner without having to construct different ranges and expend massive amounts of live ammunition. Other studies however have considered how organizations are best able to learn and adapt as groups. A common facet of these studies is the necessity for dialogue and discussion within the group while the activities are occurring, which also describes how military staff's should be analyzing problems in the midst of an ongoing conflict.⁵¹ Other data indicates the level of fidelity in the simulations are actually not necessary for the effective training of teams, as it is the process and decision making aspects that stimulate the greatest learning benefit.⁵²

In many respects the current generation of simulations used by brigade and battalion staffs attempt to provide this experience through conducting the conflict simulation in a manner that frees the staff to discuss and analyze, however none of these considerations are part of the KPPs governing the development of these systems. As discussed previously, the KPPs focus on the ability of the simulations to enable information exchange between automated systems, the Mission Command systems, as opposed to enabling staff discourse. There is little discussion as to modifying the KPP in the current simulations procurement cycle, again it is assumed that if the Mission Command systems are displaying information properly, then the staff dialogue and other activities viewed as key to developing organizations will occur as a result of the properly simulated headquarters environment. If this logic sounds suspect to the stated goal of developing

⁵¹Kareem P. Montague, "The Army and Team Learning" (Monograph, US Army School of Advanced Military Studies, 2008), 4. This monograph and other similar studies cite several works describing how groups interact and learn together, such as Peter Senge's *The Fifth Discipline*.

⁵²Cooke and Fiore, 184-187.

critical thinkers, there are others who agree, including some within the Army's own educational system.⁵³

Are alternatives to computer simulations and wargames able to meet the same training requirements while potentially providing a training environment more suited to creative or adaptive decision making? This question has not been seriously considered by the Army as an institution, though there are recent writings advocating for revisiting such ideas from authors that often comment on the military.⁵⁴ The initial activities of a group gathering the required materials to conduct such a manual simulation would necessitate constructive discussion from the very beginning of any exercise. This kind of interaction between participants is something that is not encouraged by the current systems which essentially have participants focused on their particular computer system and relying on one or two key members to synthesize information. Additionally, focusing on the display of information restricts participants understanding of the entire environment to only that which is on the screen. If more members were required to participate in the set up of the simulation from inception it would promote understanding of information and allow for productive discussion. This has been labeled as the benefits of effort and intellectual effort.⁵⁵ These kinds of advantages are rarely addressed in developing the current automated systems.

The cost of such manual simulations compared to the current structure of automated is extremely low. To purchase every battalion within brigade combat team with sufficient materials

⁵³Murray, 111. There are resources at the Army's Command and General Staff College to support manual simulations, offered during some of the elective phases of the course of instruction.

⁵⁴Martin Van Creveld, *Wargames: From Gladiators to Gigabytes* (Cambridge: Cambridge University Press, 2013), 256-260; Sabin, *Simulating War*.

⁵⁵Sabin, xix.

to run manual wargames would cost less than a million dollars.⁵⁶ This would include providing the required materials such as books and maps and paper. This estimate also includes formations such as signal brigades and brigades in the reserve component. The simulations functional area can remain the oversight for these types of simulations. The ability of such manual simulation wargames to provide training opportunity is essentially limited only by imagination. The cost of this measure makes it difficult to understand why it has been so pushed aside over the last twenty years.

CONCLUSION

The Army has spent an average of over 500 million dollars on simulations for the past decade. This number contains the costs associated with those simulations aimed at training brigade and battalion staffs as discussed previously. Based off the appropriated funds from the Army's fiscal year 2014 budget, these costs are at least 44 million dollars. The appropriated funds in 2013 were 39 million.⁵⁷ These are the costs directly related to those systems utilized at the brigade level and below for simulations involving the entire unit, such as warfighter exercises or command post exercises, and excludes costs of systems utilized for individual soldiers or vehicle crews. The total cost is actually higher as there are other associated costs such as infrastructure maintenance and hardware procurement which cover multiple systems, not only those used at

⁵⁶Derived by multiplying the modern cost of a manual simulation equivalent to those previously thought to be valuable the last time the US Army considered this, approximately two hundred dollars, by an estimated number of battalions contained in all the brigades in the US Army FORSCOM and TRADOC. Even erring on a large estimate which includes units that likely would not require these materials such as recruiting battalions, the number still comes in lower than one million dollars.

⁵⁷Department of Defense, *Research, Development, Test and Evaluation, Army (RDT&E)—Volume III, Budget Activity 6*.

brigade and below. However the Army's budgetary documents do not draw such minute distinctions.

In the overall Department of Defense budget, 44 million dollars may not seem a great sum of money. When considered over time, such as the period since the initiation of the current conflicts in 2001, this cost multiplied over twelve years is over 500 million dollars, or half a billion dollars. With such a sum invested, it is surprising that there are so many areas within simulations that are addressed by line in the budget that still require such sums of money and effort. Some areas truly raise a question as to their validity, for example if these simulations are to enhance training for soldiers, what requirements such as "realistic, culturally-specific virtual humans able to interact with other virtual humans," are supposed to provide remains to be qualified.⁵⁸ While bureaucratic behavior is notoriously difficult to adjust, it would seem wasteful to continue to pursue such lines of effort without discrete justification with regard to training value.⁵⁹

The initial question of what the benefit these systems have brought to the Army's brigade and battalion staffs in training terms is still debated. As a quantifiable measure, perhaps the view of the brigade commander's and staffs themselves can be useful. If one considers the Brigades as the customers of the product that the simulations acquisitions are providing, a measure of the effectiveness can be provided. The previously cited studies from the GAO in 1993 and PEO-

⁵⁸Department of Defense, *Research, Development, Test and Evaluation, Army (RDT&E)—Volume I, Budget Activity 2*. This exact quote is found in the planned programs section of PE:0602308A: Advanced Concepts and Simulations. While in theory this concept would be useful for higher echelon wargames to properly model civilian populations, as this is listed in conjunction with training development the benefit to training soldiers at a brigade and below level is not qualified.

⁵⁹Conrad R. Schmidt, *Changing Bureaucratic Behavior: Acquisition Reform in the United States Army* (Santa Monica: RAND, 2000), 34-37.

STRI in 2013 both had Brigade commanders and staffs stating they were satisfied with the simulations available on their installations 45 percent of the time. This number can represent the brigades satisfaction rating as a customer. A recently written article in Forbes magazine presents that globally across industries the customer satisfaction rating averages to 86 percent.⁶⁰ While the military is not the private sector, such a poor showing in satisfaction by the “customer” should be addressed. It must also be noted that this number of 45 percent has not changed much in the twenty years between studies. When one considers that nearly a billion dollars has been spent along this line of development in the twenty years separating these studies, the consistently low satisfaction rating becomes more appalling.

With respect to the issues that have been presented, training considerations, cost in development and educational theory, several recommendations stand out without difficult analysis. The estimated cost of equipping the Army’s operational units with manual simulations and requiring an already existing group of functional area officers to oversee the implementation is a low cost alternative that would require very little time to field. The issue that would likely cause the greatest issue would be the time it would take for soldiers to learn the new system. This is a concern with any new system, the lower cost however practically demands this be attempted.

Utilizing cost effective manual simulations which would require very little if any outside support would also enable units to conduct multiple repetitions of exercises, or modify them, as they see fit. Training with Mission Command systems can still be supported, as the information being determined through the conduct of the manual simulation wargame can be entered into

⁶⁰Eric Savitz, “Customer Satisfaction by the Numbers: An Industry Breakdown,” *Forbes* (19 April 2012), http://www.forbes.com/sites/ciocentral/2012/04/19/customer-satisfaction-by-the-numbers-an-industry-breakdown/#/?&_suid=139880113449705807466363078417 (accessed 2 April 2014).

mission command systems and train those who will predominantly be utilizing them, forcing a level of understanding beyond just looking at a display screen.

The Army's continuing struggle to standardize programming methods for its Mission Command Systems must be addressed. This issue was raised when computers began taking the lead in Army procurement and has been a source of consternation ever since.⁶¹ As an adjunct, this would include programming standards for simulations. While the Army currently has an overall goal to standardize simulations programming, it is progressing at a glacial rate of transitioning towards that goal. The lack of standardization in the Army's simulations has caused numerous concerns as discussed in this monograph. The National Simulation Center at Fort Leavenworth in accordance within the Department of the Army's guidelines has established a strategy for attempting to remedy these issues of programming, however estimates place this goal of standardizing the simulations coding at least five years away, 2019 at the earliest.⁶² Given that this goal has been stated previously without being realized, it would reason that the likelihood of standardization occurring in 2019 is fair at best. With this analysis in place it is recommended that funding for developing computer simulations be discontinued until 2019 and the standardization is complete. The funds saved can be used to provide the recommended manual simulations and have funds left over to divert to other concerns within the simulations arena. This recommendation states that current systems fielded be funded to continue their use, but that funding for new research be stopped.

⁶¹Steven C. Bankes, *Issues in Developing the Potential of Distributed Warfare Simulation* (Santa Monica: RAND, 1992), 11; Held, Newsome and Lewis *Commonality in Military Equipment*.

⁶²US Army Combined Arms Center, Training Report presented at Training Integration Forum, 27 February 2014.

With budgets becoming more constrained in the near future, manual simulation methods should be seriously considered as the Army looks to train adaptable units for uncertain threats at a sustainable cost. The advantages alternatives such as manual simulation provide clearly include other aspects the Army has stated are desirable, such as creative thinking and adaptability. Such methods can be distributed quickly and they offer potential for educational and training for brigade commanders and staffs at a fraction of the cost of the current automated simulations.

BIBLIOGRAPHY

- Abella, Alex. *Soldiers of Reason*. New York: Harcourt Inc., 2008.
- Allen, Thomas B. *The War Game*. New York: McGraw-Hill, 1987.
- Banks, Steven C. *Issues in Developing the Potential of Distributed Warfare Simulation*. Santa Monica, CA: RAND, 1992.
- Besser, David, and Donald Lampton. "Development of TRAX-I: A Tank Platoon Game Modifying Dunn-Kempf." US Army Research Institute for the Behavioral and Social Sciences report. Washington, DC: Government Printing Office, 1985.
- Brewer, Garry D., and Martin Shubik. *The War Game: A Critique of Military Problem Solving*. Cambridge: Cambridge University Press, 1979.
- Chairman of the Joint Chiefs Staff. Instruction 3170.01 H, *Joint Capabilities Integration and Development System*. Washington, DC: Government Printing Office, 10 January 2012.
- Cooke, Nancy J., and Stephen M. Fiore. "Cognitive Science-Based Principles for the Design and Delivery of Training." In *Learning, Training and Development in Organizations*, edited by Steven Kozlowski and Eduardo Salas. New York: Routledge, 2009.
- Clemente, Steven E. *For King and Kaiser! The Making of the Prussian Army Officer*. Westport: Greenwood Press, 1992.
- Department of the Army. Army Doctrine Publication (ADRP) 7-0, *Army Electronic Publications and Forms*. Washington, DC: Government Printing Office, 2012.
- _____. Army Doctrine and Training Publications (ADRP) 5-0, *The Operations Process*. Washington, DC: Government Printing Office, 2012.
- Department of Defense. Directive 5000.59, *DoD Modeling and Simulation (M&S) Management*. Washington, DC: Government Printing Office, 8 August 2007.
- _____. *Research, Development, Test and Evaluation, Army (RDT&E)—Volume III, Budget Activity 6*. Washington, DC: Government Printing Office, March, 2014.
<http://www.asafm.army.mil/offices/BU/BudgetMat.aspx?OfficeCode=1200> (accessed 9 April 2014).
- Dunnigan, James. *The Complete Wargames Handbook*. Revised Edition. New York: William Morrow and Company, 1992.
- Gates, Brian K. "Army Simulations: Moving Towards Efficient Collective Training Sims." Monograph, US Army School of Advanced Military Studies, 2002.
- Government Accounting Office. *Army Training: Commanders Lack Guidance and Training for Effective Use of Simulations*. GAO Report. Washington, DC: Government Printing Office, 1993.

- Hairston, Ronald. "Computer Driven Battle Simulations: How to Integrate Them Into Reserve Component Training". Master's thesis, U S Army Command and General Staff College, 1980.
- Hattendorf, John B. *Sailors and Scholars*. Newport, RI: Naval War College Press, 1984.
- Hausrath, Alfred Hartmann. *Venture Simulation*. New York: McGraw Hill, 1971.
- Held, Thomas, Bruce Newsome, and Matthew Lewis. *Commonality in Military Equipment*. Santa Monica, CA: RAND, 2008.
- Holyoak, Keith. *The Cambridge Handbook of Thinking and Reasoning*. New York: Cambridge University Press, 2005.
- Homans, Charles. "Wargames." *Foreign Policy* 188 (September/October 2011): 30.
- Hughes, Wayne P., ed. *Military Modeling for Decision Makers*. Washington DC: Military Research Operations Society, 1997.
- Jonassen, David, Chad Carr, and Hsiu-Ping Yueh. "Computers as Mindtools for Engaging Critical Thinkers." *TechTrends* 43, no. 2 (March 1998): 24-32.
- Kahneman, Daniel. *Thinking, Fast and Slow*. New York: Farrar, Strous, and Giroux, 2011.
- Kolb, David A. *Experiential Learning: Experience as the Source of Learning and Development*. Englewood, CA: Prentice Hall, 1984.
- Livermore, W. R. *The American Kriegspiel*. New York: Houghton, Mifflin and Company, 1879.
- Macedonia, Michael. "Games, Simulation and the Military Education Dilemma." *Internet and the University: 2001 Forum* (2001): 157-167.
- MacIntyre, Kerry. "Analysis in the Utility of Commercial Wargaming Simulation Software for Army Organizational Leader Development." Monograph, US Army School of Advanced Military Studies, 2000.
- McHugh, Francis J. *Fundamentals of Wargaming*. Newport, RI: Naval War College, 1966.
- McMaster, H. R. *Dereliction of Duty*. New York: Harper Collins, 1997.
- Montague, Kareem P. "The Army and Team Learning." Monograph, US Army School of Advanced Military Studies, 2008.
- Morris, Edmund. *Theodore Rex*. New York: Random House, 2001.
- Murray, Nicholas. Review of Philip Sabin, "Simulating War." *Military Review* 93, no. 2 (March/April 2013), 111.
- Neyland, David. *Virtual Combat*. Mechanicsburg, PA: Stackpole, 1997.

- Perla, Peter. "What Wargaming is and is Not." *Naval War College Review* 38, no. 5 (1985): 70-78.
- Perla, Peter. *The Art of Wargaming*. Annapolis, MD: Naval Institute Press, 1990.
- Prados, John. *Pentagon Games*. New York: Harper Row, 1987.
- Prange, Gordon W. *At Dawn We Slept*. New York: McGraw-Hill, 1981.
- Riecken, Mark, and Johnny Powers. "The Value of Simulation in Army Training." Presented at Interservice/Industry Training, Simulation and Education Conference (I/ITSEC) 2013.
- Sabin, Philp. *Simulating War*. New York: Continuum International, 2012.
- Savitz, Eric. "Customer Satisfaction by the Numbers: An Industry Breakdown." *Forbes* (19 April 2012). http://www.forbes.com/sites/ciocentral/2012/04/19/customer-satisfaction-by-the-numbers-an-industry-breakdown/#./?&_suid=139880113449705807466363078417.
- Schifferle, Peter. *America's School for War*. Lawrence, KS: University of Kansas Press, 2010.
- Schmidt, Conrad R. *Changing Bureaucratic Behavior: Acquisition Reform in the United States Army*. Santa Monica, CA: RAND, 2000.
- Schoemaker, Jeffrey. "The Application of Off-the-Shelf Military Simulations to Train Decision Making and Teach Tactics." Master's thesis, US Army Command and General Staff College, 2003.
- Schrader, Charles R. *History of Operations Research in the United States Army*, vol. III. Washington DC: Government Printing Office, 2009.
- Sorenson, David S. *The Process and Politics of Defense Acquisition*. Westport: Praeger Security, 2009.
- Starr, Stuart. "Good Games." *Naval War College Review* 54, no. 2 (2001): 89-97.
- Tolk, Andreas, ed. *Engineering Principles of Combat Modeling and Distributed Simulation*. Hoboken: Wiley, 2012.
- Totten, Charles A. L. *Strategos: A Series of American Games of War Based on Military Principles*. New York: D. Appleton and Company, 1880. CARL online resource: <http://hdl.handle.net/2027/uc1.b3158010> (accessed 4 February 2014).
- Van Creveld, Martin. *Wargames: From Gladiators to Gigabytes*. Cambridge: Cambridge University Press, 2013.
- Vigo, Milan. "German Wargaming." *Naval War College Review* 65, no. 4 (2012): 106-147.
- Washburn, Alan and Moshe Kress. *Combat Modeling*. New York: Springer, 2009.
- Wass de Czega, Huba. "Wargaming Insights." *Army* 53, no. 3 (2003): 36-44.

Willmuth, Thomas. "The Study of Military History through Commercial War Games: A Look at Operation Crusader with the Operational Art of War." Master's thesis, US Army Command and General Staff College, 2001.

Werning, Stefan. *Real Wars on Virtual Battlefields*. New Brunswick: Transaction Publishers, 2009.

US Army. Combined Arms Center. Training Report presented at Training Integration Forum, 27 February 2014.

_____. *PEO-STRI Desk-Side Reference Guide*. Rockville, IL: KMI Media, 2013.