Wargaming Evolved: Methodology and Best Practices for Simulation-Supported Wargaming

Per-Idar Evensen
Norwegian Defence Research Establishment (FFI)
Kjeller, Norway
per-idar.evensen@ffi.no

Svein Erlend Martinussen
Norwegian Defence University College (NDUC)
Oslo, Norway
semartinussen@fhs.mil.no

Marius Halsør
Norwegian Defence Research Establishment (FFI)
Kjeller, Norway
marius.halsor@ffi.no

Dan Helge Bentsen
Norwegian Defence Research Establishment (FFI)
Kjeller, Norway
dan-helge.bentsen@ffi.no

ABSTRACT

When developing and assessing future force structures, wargaming is a key activity for better understanding the strengths and weaknesses of the force structures. Today simulation systems let us create synthetic environments that to a high degree replicate the physical properties of the real world for these wargames. Furthermore, advances in artificial intelligence (AI) and behavior modeling has given us more realistic computer-generated forces (CGF) that can execute battle drills and lower level tactics with a fairly high degree of realism. However, at the higher levels of the chain of command, AI has not yet replaced human leadership, and planning and conducting simulated operations require participation of officers.

For more than a decade, the Norwegian Defence Research Establishment (FFI) has supported the Norwegian Army with conducting wargames for capability planning, with varying degree of simulation support. Throughout this period, the wargames have evolved from what can be described as computer-assisted wargames towards more realistic simulation-supported wargames. Moreover, to get a closer understanding of the deterrent effect of the force structures, which may not be observable when monitoring the actual gameplay, our emphasis has also shifted towards replicating the planning process more properly, and especially on monitoring the planning process of the opposing force. For example, it has been important to find out to what extent specific structure elements discourage the opposing force from taking certain actions.

In this paper, we describe our evolved methodology for simulation-supported wargaming, which includes a preparation phase, a gaming and execution phase, including a planning process, and an analysis phase. Furthermore, we discuss what type of data and results we are able to extract from the wargaming sessions, and present a set of best practices for how to conduct successful simulation-supported wargames.

ABOUT THE AUTHORS

Per-Idar Evensen is a Senior Scientist at the Norwegian Defence Research Establishment (FFI), where he has worked since 2006. His research work focuses on modeling and simulation (M&S) of land force operations at different levels for experimentation and analysis purposes, and he has a special interest in simulation systems based on game technology. He has a Master of Science degree in Computer Science from the University of Oslo in 2004.

Svein Erlend Martinussen is an Associate Professor at the Norwegian Military Academy, where he has worked since 2017. He has more than 20 years' experience as a researcher and operations analyst for the Norwegian Army at home and abroad. He has a PhD in engineering from The University of Greenwich, and a master's in physics from the University of Oslo.

Marius Halsør is a Principal Scientist at the Norwegian Defence Research Establishment (FFI), where he has worked since 1998. He has developed and utilized several simulation tools for experimentation and analysis for land force operations at tactical levels and below. He has a Master of Science degree from NTNU from 1997.

Dan Helge Bentsen is the Research Manager of Land Operations at the Norwegian Defence Research Establishment (FFI), where he has worked since 2009. His work has mainly focused on the use of modeling and simulation (M&S) tools to evaluate the combat effectiveness of different land force structures and components. He has served as a tank commander in the Norwegian Army, and has also experience from deployments to Afghanistan. He has a bachelor's degree in Media Technology and Design from the University of Agder.

Wargaming Evolved: Methodology and Best Practices for Simulation-Supported Wargaming

Per-Idar Evensen
Norwegian Defence Research Establishment (FFI)
Kjeller, Norway
per-idar.evensen@ffi.no

Svein Erlend Martinussen
Norwegian Defence University College (NDUC)
Oslo, Norway
semartinussen@fhs.mil.no

Marius Halsør
Norwegian Defence Research Establishment (FFI)
Kjeller, Norway
marius.halsor@ffi.no

Dan Helge Bentsen
Norwegian Defence Research Establishment (FFI)
Kjeller, Norway
dan-helge.bentsen@ffi.no

INTRODUCTION

When developing and assessing future force structures, *wargaming* is a key activity for better understanding the strengths and weaknesses of the force structures. Today simulation systems let us create synthetic environments that to a high degree replicate the physical properties of the real world for these wargames. Furthermore, advances in artificial intelligence (AI) and behavior modeling has given us more realistic computer-generated forces (CGF) that can execute battle drills and lower level tactics with a fairly high degree of realism. However, at the higher levels of the chain of command, AI has not yet replaced human leadership, and planning and conducting simulated operations require participation of officers.

For more than a decade, the Norwegian Defence Research Establishment (FFI) has supported the Norwegian Army with conducting wargames for capability planning, with varying degree of simulation support. Throughout this period, the wargames have evolved from what can be described as computer-assisted wargames towards more realistic simulation-supported wargames. Moreover, to get a closer understanding of the deterrent effect of the force structures, which may not be observable when monitoring the actual gameplay, our emphasis has also shifted towards replicating the planning process more properly, and especially on monitoring the planning process of the opposing force. For example, it has been important to examine to what extent specific structure elements discourage the opposing force from taking certain actions.

First, in this paper, we briefly describe the background for this work. Secondly, we give an introduction to wargaming in general, including short discussions of types, application areas, and its relation to modeling and simulation (M&S) and experimentation. Then, we describe our evolved methodology for simulation-supported wargaming, which includes a preparation phase, an execution phase, including a joint operational planning process, and an analysis phase. We also discuss what type of data and results we are able to extract from the wargaming sessions. Finally, we briefly discuss desired properties of simulation systems suitable for supporting wargames and present a set of best practices for how to conduct successful simulation-supported wargames.

BACKGROUND

Wargames in various forms have been conducted at FFI for decades. The idea to do simulation-supported force structure evaluations emerged when researchers at FFI started cooperating on scenarios for individual simulation-supported system assessments (Martinussen et al, 2008). However, the first time an interactive, brigade-level simulation system utilizing semi-automated forces (SAF) was used as basis for a wargame at FFI, was in 2010. In project "Future Land Forces" the performance of five fundamentally different land force structures were evaluated through a series of computer-assisted wargames (Hoff et al, 2012; Hoff et al, 2013). The goal was to rank these structures based on their relative performance. In addition, the wargames revealed several strengths and weaknesses of the evaluated structures. The simulation tool in use was quite simple, but it was useful for keeping track of the movement of units and calculating the results of duels and indirect fire attacks.

After this, FFI has supported the Norwegian Army with conducting several simulation-supported wargaming series for capability planning, both on-site and at the Norwegian Army Land Warfare Centre. The wargames have been conducted as two-sided (Blue and Red), closed (with limits on available information) wargames at the tactical and operational levels, and the simulated operations have included between a battalion and a brigade of land forces on each side. The total number of players has been anywhere between ten and one hundred, and the duration of a wargame has typically been from one day to one week. Figure 1 shows a picture from a simulation-supported wargaming session at FFI in 2014.

Figure 1. Simulation-Supported Wargaming Session at FFI in 2014.

INTRODUCTION TO WARGAMING

We do not really know when humans first started wargaming, but the concept of using small objects to represent maneuver of warriors is probably almost as old as war itself. Professional wargaming in its modern form however, originates from a game known as the *Kriegsspiel*, developed in Prussia in the 1820's. The Kriegsspiel was the first wargaming system to be adopted by a military organization for professional use like analysis and training. While the Prussians were the first to embrace wargaming, other nations soon followed.

History has shown that the interest for wargaming tends to go in cycles. Now we are again seeing an increasing interest for wargaming, both in Norway and internationally. For the last few decades wargames have also had the opportunity to benefit from more and more realistic computer-based simulations.

It is a well-known fact that military innovation thrives during wartime. Explanations as to why this is the case may differ depending on how one perceives innovation. Creativity surely is spurned when lives are at stake, but it may also be that a simple mechanism of selection is at work. Only the innovators that live to tell the tale leave ideas that may be propagated to others. In peacetime the wargame ideally replaces the war as a vessel of destruction of poor ideas. No ideas, whether old or new, should be considered sacred. Alternatively, organizational infighting and power struggle replaces the enemy, and innovations may end up not even being tested before they are brought to the battlefield.

Definitions of Wargame

The North Atlantic Treaty Organization (NATO) defines a wargame as "a simulation of a military operation, by whatever means, using specific rules, data, methods and procedures" (NSO, 2000). In his book "The Art of Wargaming: A Guide for Professionals and Hobbyists" (Perla, 1990), wargame expert Peter Perla defines a wargame as "a warfare model or simulation that does not involve the operations of actual forces, in which the flow of events affects and is affected by decisions made during the course of those events by players representing opposing sides". The essential parts of a wargame, emphasized in Peter Perla's definition, are the *human players representing opposing sides* and *their decision-making*. It is important to recognize that "although war currently appears to be dominated by technology, warfare is fundamentally a human issue" (Storr, 2009). As a representation of war, "this active and central involvement of human beings is the characteristic that distinguishes wargames from other types of models and simulations" (Perla, 1990). Furthermore, "a value unique to all [wargames] is the occurrence of previously unknown issues, insights, or decisions that arise during the conduct of a game" (Burns, 2015), especially when facing a determined and dynamic opponent.

Types of Wargames

There are several types or styles of wargames ranging from simple seminar type, discussion-based wargames to more detailed wargames with physical models on a map, and furthermore even more detailed and more realistic wargames with computer-based simulation support. The different types of wargames have different advantages and disadvantages regarding complexity, resource usage, fidelity and credibility.

Seminar type wargames are easy to conduct, require few resources, and are suitable for exchanging, challenging and developing new ideas, especially in the early phase of a study or capability planning process. This type of wargames, however, can often be too much based on opinions and assumptions and therefore lack credibility.

Manual wargames will in general have a much lower fidelity than simulation-supported wargames. The classic problem with manual wargames is how to "reproduce enough of the physical reality without so overburdening the player with game artificialities that his experience of play only vaguely resembles real-life command" (Perla, 1990). On the other hand, simulation-supported wargames generally require more resources and usually take more time to prepare and conduct.

The value of using computer-based simulations to support wargaming is first and foremost in having a system to automatically keep track of the forces, calculate the detections of their sensors, and evaluate the results of duel situations and indirect fire attacks. In addition, computer-based simulations are well suited for realistic representation of uncertainty and *fog of war* by adding filters on the ground truth.

Which wargaming type to use will of course depend on the actual research question or study, in addition to available time and resources. Not every study requires a simulation-supported wargame with the highest fidelity. When selecting an approach, "[t]he key consideration, apart from resource availability, is determining what is the lowest level of cost/venue necessary to provide a valid product which meets the specific study requirement" (Yanoschik, 2016).

Application Areas

There are mainly two application areas for professional wargames:

1. Training and education
2. Research and analysis (e.g. capability planning or plan testing)

In this paper we focus on wargames for research and analysis (analytical wargames), and especially wargames aimed at assessing force structures. The purpose of *analytical wargames* is to gain insight into complex issues related to warfare.

Modeling and Simulation, Wargaming and Experimentation

The scenario, data, rules, and players of a wargame form a model of warfare. The execution of that model over time is a simulation. When we say simulation-supported wargame, we mean a wargame supported by computer-based simulations. A simulation-supported wargame can in M&S terminology be classified as a *human-in-the-loop* (HITL) simulation where the human players interact with a *constructive simulation* with *semi-automated forces* (SAF). The human players are thus a part of the simulation as a whole. A characteristic of HITL simulations is that the humans influence the outcome in such a way that it is difficult, if not impossible, to reproduce exactly.

M&S is essential for most defense experimentation. Analytical wargames can be categorized as a type of experimentation known as *discovery experimentation*. Discovery experimentation involves introducing novel systems, concepts, organizational structures, technologies, or other elements to a setting where their use can be observed and catalogued (Alberts & Hayes, 2002).

M&S, wargaming and experimentation are in many ways fundamentally intertwined. They all exist on a spectrum ranging from very simple to highly complex, and there are several opportunities for cross-domain solutions between these techniques (Page, 2016).

METHODOLOGY

Wargaming is an essential tool for developing, testing and analyzing new force structures. Through wargaming it is possible to gain insight into how well suited a force structure is for a given scenario and reveal a structure's strengths and weaknesses. Having a good execution plan is, however, paramount for conducting successful wargaming experiments and getting the most out of the collected data from the events. In this section we describe our methodology for simulation-supported wargaming, which has evolved through our experiences with planning, execution and analysis of wargaming experiments over the past ten years.

In addition to Peter Perla's book (Perla, 1990), there are several guides for wargaming in general (Burns, 2015; UK MoD, 2017). The methodology described in this section is specially tailored towards analytical wargaming for supporting the development of future force structures. Typically, we use this methodology to assess and compare the performance of different force structure alternatives, which may vary with regard to: *composition of material and equipment*, *tactical organization*, or *operational concept*.

Small countries face a dilemma when developing force structures to deter enemies with a larger pool of force elements. The enemy may be expected to see what defense structure changes that are made and may select other, and more suited, elements from the pool when applying military power. If the small country force structure is specialized, to counter expected enemy courses of action (COAs), the enemy may chose something entirely different from his pool and the enemy COA may change dramatically.

Developing force structures is a slow and public process, while selecting from a large pool of force elements and creating new COAs is a fast and hidden process. It may seem like an impossible task to achieve deterrence under such circumstances, but we have observed in several instances how low cost changes to the force structure have a big impact on the COAs the enemy may consider using (Daltveit et al, 2017; Haande et al, 2017). The changes to Soviet tactics in Afghanistan after the introduction of hand held air defense missiles for the mujahideen in 1988 (Grau, 1996) is a good example of the kind of effect we have seen during the Red force planning in wargames. Presence and posture was also observed to have a deterrent effect. In addition, society, landscape and climate influenced the Red planning process. This all comes down to risk assessment on the enemy side during planning and development of COAs. To observe the impact of force structure changes, it is necessary to have analysts observe the planning process of the Red cell before a wargame, and not only during the simulated battle. Deterring the enemy from attacking is the intention of any force structure development, and the only way to observe the deterrent effect is during enemy planning.

In decision theory, risk is a necessary factor to consider to be able to make rational choices. The von Neumann-Morgenstern (vNM) decision theory is based on actors assessing choices by considering lotteries with given probabilities and outcomes (von Neumann & Morgenstern, 1944). The element of risk also needs to be present in planning processes. If the planning process of one side is known to any other side participating in a wargame, a part of the element of risk disappears. This would reduce the planning process to just assessing a known enemy COA, as opposed to assessing a spectrum of possible COAs and probabilities. Therefore it is important that the scenario definitions do not limit the enemy planning process, and that all planning processes are monitored, and especially the enemy planning process.

Our methodology for wargaming experiments consists of three major phases:

1. Preparation phase
2. Planning and execution phase
3. Analysis phase

The relationship between the different phases is illustrated in Figure 2, where the planning process and the game execution phase is the core of the experiments.

Whereas a wargame has rules when it eventually starts, the process of choosing the type of game and the context around it has no rules. As such, the process of organizing a gaming event may be viewed as a *metagame*, or a game without rules. Metagames may be studied by means of confrontation analysis (Curry & Young, 2017). For instance, a wargame at the joint level would include participants that traditionally are rivals for funding. Participants from the air force, the navy and the army may have differing interests when it comes to how scenarios should be formulated, what assumptions that should be made about future technology, how combat effects should be assessed and so on. The same goes for branches within each of the domains. The metagame may have more influence on the outcome of a force structure analysis than the actual wargame. The metagame is not limited to the wargaming execution. The fight about the analysis and the reporting afterwards is also subject to conflict of the same type that occurs during preparations. This is illustrated in Figure 2 by the layer that exists outside the core methodology.

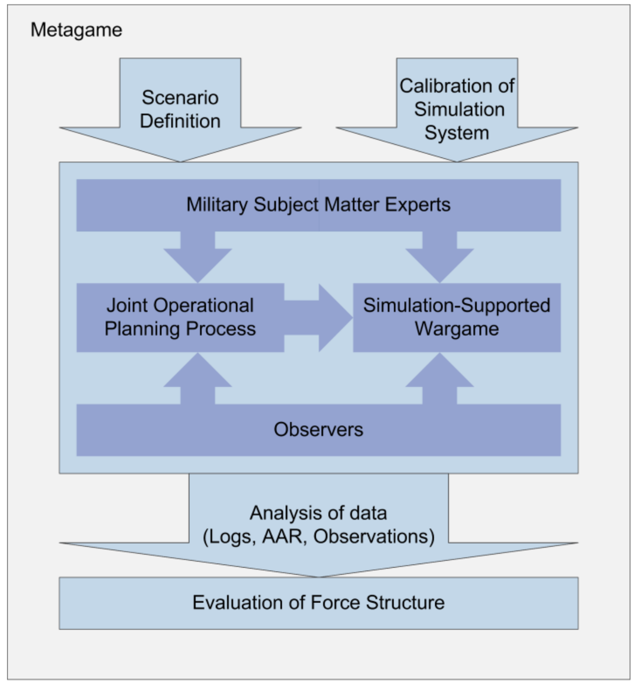

Figure 2. Illustration of Methodology for Wargaming Experiments

Preparation Phase

The preparation phase includes everything that needs to be done before the game execution phase can be started. The most important preparations are:

- Establish a common understanding of the objective of the wargaming experiments
- Define overall scenario, including external conditions and limitations
- Choose one or more simulation systems and calibrate simulation models
- Define order of battle (OOB) for Blue and Red side

The Norwegian military long term planning process is full of examples of stakeholders fighting for turf. This is especially noticeable in the preparation phase of wargames. One of the reasons is that we do not properly separate the role with the power to invent changes from the role with the power to assess and accept changes. When this is the case, stakeholders will try to influence both what should be the objective of the game, and what method to use. In the worst case scenario a limited number of stakeholders decide the future defense structure by means of *scenario-based structured discussions*.

Scenario-based structured discussions are defined by not including a dedicated Red cell player (UK MoD, 2017). When we include a Red cell in our methodology, we exclude scenario-based structured discussions from the range of acceptable wargaming techniques. This removes a lot of pitfalls from the wargames. Many of the actors participating in the preparation phase of the wargame have ideas and values invested in the endeavor, and frequently fight for certain outcomes of the metagame of the planning phase. We have seen scientists, high ranking officers and bureaucrats fight to keep scenario-based structured discussions as the sole tool for selecting the future defense structure.

The Joint Requirements Oversight Council (JROC) is a good example of an institution that handles the turf fight with a sound decision structure. (CJCS, 2018). The way the U.S. military separates the inventors of ideas from the power to review their usefulness is entirely in accordance with Montesquieu's principle of separation of powers, though on a smaller scale than the political. The way defense planning and wargaming have been carried out in Norway, in a lot of cases one will find actors both generating ideas for future force structures, and assessing the same structures by participating in scenario-based structured discussions. Introducing Red cell players, and free and unhindered planning on the opposing side, removes this potential for misuse of power. A peculiar result of not properly wargaming force structures has been the sub-optimization of force structures to combat fixed assumed enemy COAs. By not properly wargaming such force structures the proponents of the structural changes succeed in beating their favorite enemy COAs, but fail at challenging their own ideas. Exposing this kind of wargaming error may not be easy, since it is a result of the metagame and the preparation phase of a poorly structured bureaucratic planning of wargames, and not necessary a fault of the wargame itself.

Planning and Execution Phase

The planning and execution phase consists of two separate activities: (1) a joint operational planning process for both sides and (2) the simulation-supported wargame.

Joint Operational Planning Process
In this activity the Blue and Red cell separately develops their initial plan for the operation based on the overall scenario and a controlled flow of intelligence information. The plans are preferably not a part of the overall scenario, and both sides can develop their plans freely. This also means that the plans for the two opposing sides remain unknown to each other.

The joint operational planning process can in principle be done much in the same way as in reality, without any simplifications. This is an activity that should be prioritized in the same way as the simulation-supported wargame, also with regards to staffing.

During the planning process the players have to discuss different options and develop a COA which is shaped by their perceived strengths and weaknesses of the opposing force structure. Observing the planning process on both sides and revealing the underlying reasons for the decided COA, can give valuable information regarding a force structure that may not be observable in the execution of the wargame itself. The deterrent effect of a force structure is an example of something that may only be observable during the planning process.

Simulation-Supported Wargame
The wargame itself is conducted as a simulation-supported, two-sided (Blue and Red) wargame, where the operation is simulated in a constructive simulation system with SAF. Within game theory, this type of wargame can be categorized as a *non-cooperative, asymmetric, sequential game of imperfect information*.

The actors in the wargame are the players on both sides and a team of umpires or adjudicators. It is important to remember that wargames are only as good as its players. The players are military subject matter experts (SMEs) and officers. To have a balanced game, it is crucial not to down-prioritize the Red team. This type of wargame, led by adaptive and largely unrestricted thinking opponents, tends to become highly dynamic, adversarial and competitive.

For analytical wargames, realistic simulations are important to strengthen the credibility of the results. Military operations, and especially land force operations, are complex in nature, and simulations of such operations, with sufficient realism, is very challenging (Evensen & Bentsen, 2016**)**. It is therefore important to have experienced umpires that monitor the simulation, and if necessary make appropriate manual adjustments to the outcomes.

The metagame to some degree also comes into play during the simulation-supported wargame. We have seen stake-holders withdraw competent officers from simulation-supported wargames, to replace them with less skilled personnel, most probably to reduce the credibility of a wargame that the stakeholder did not want to be successful. We have seen umpires struggle against interventions from higher ranking stakeholders visiting the wargame. These problems have existed for many years in Norway, and history is full of similar examples (Perla, 1990). A clear methodological approach is intended to counter some of the shortcomings of previous wargaming experiments.

Analysis Phase

The analysis is based on observations and data from the planning process, in addition to the observations and data collected from the execution of the simulation-supported wargame itself.

During the planning process, it is important to monitor and document the discussions closely. The primary purpose of a defense force is to prevent war; therefore the considerations made in the planning process are perhaps the most important results from the entire wargame. The preventive properties of a force structure and a posture can only be seen when the enemy considers it before a war starts. Several alternative COAs and maneuvers will be considered during the planning phase. Many of these will be discarded, and some will be accepted, for various reasons. These reasons must be recorded. The reason why Red decided that a certain COA was not viable may be due to certain structure elements or expected strategy from Blue. If Red has to abandon a plan due to elements in the Blue OOB, then these elements already have proven valuable to Blue – even if these elements end up not inflicting any direct damage to Red forces during the following simulated operation.

During the actual simulation-supported wargame, lots of data may be recorded. It is tempting to put a lot of importance to the "kill ratios" of various structure elements. However, such data should be used with extreme caution – if at all. For example, in a certain simulation, artillery may cause a lot of damage to the opposing force. However, this was most likely not solely due to the magnificence of the artillery units. What caused the enemy to become exposed to the artillery? How was the enemy forces detected? How was he fixed before the artillery attack? How was the artillery able to get to their positions and deliver their ammunition without being attacked by enemy forces? The enemy may have discarded a COA which would have made him less exposed to artillery. Why did that COA have to be abandoned? These questions are important, and the answers are more interesting than affirming that artillery fire, when delivered on a stationary and dense target, is effective.

What is perhaps more important to pay attention to during the actual simulation, are the decisions that are made by the commanders on both sides. If a window of opportunity arises for one of the sides, why is that? How is that side able to exploit such an opportunity? Are there any ways they consider exploiting the opportunity, but are unable to? If so, why? To collect such information, it is important that the commanders openly discuss their options. It is not only why they make the choices they do that is important, it may often be equally important why other choices are *not* made.

Identifying major strengths and weaknesses of a force structure and its utilization is an important part of the analysis phase. Examining the considerations made by both sides, both during the planning phase and the wargaming phase, is the best way to do this. This is not an exact science as such data are qualitative in nature. Finding key elements that made it possible to use a certain COA, or perhaps a missing capability which allowed the enemy better options, are better identified in this matter than looking solely at what weapon systems destroyed which enemy systems.

The analysis phase may also be subject to fights outside the context of the agreed upon wargame methodology. Even the report writing after the event may be influenced, when roles are not well separated and stakeholders are allowed to disproportionately influence the process. One of the authors had the bad fortune of sanctioning modifications to the observations of the Red cell planning activity the first time this methodology was applied. Two systems were unduly added to the analysis text after the observations were finished. They were credited with a preventive effect that they were not observed to have had during the Red cell planning process. One of the systems had also suffered a catastrophic destruction during gameplay, but had been reintroduced on the battlefield on the request of the system owner. Both systems were cherished by their own branches. In retrospect this takes a toll on ones integrity as an analyst.

OUTPUT DATA AND RESULTS

In general, we strive to capture as much data as possible from the wargaming sessions. Depending on the simulation system used to support the wargame, a variety of output data can be recorded. It is for instance usually possible to record how far various units have moved, how much ammunition and fuel they have used, and other logistical data. *Kill matrices* are also usually recorded. This is essentially a matrix showing which units on one side killed which units on the other side. A lot of other quantitative data can also be recorded. In addition comes a lot of qualitative data. This includes, as noted earlier, observation of the planning process, and discussions with the players involved in the planning process. Also, it includes observations of decisions made during the game, and discussions with the players during or after the game.

It is often tempting to put a lot of weight on quantitative data, such as the kill matrices, and perhaps less weight on qualitative data. Quantitative data are easier to analyze, and are also often considered more objective than qualitative data like the decisions and considerations of the players. However, it is important to remember that the quantitative data are dependent on the decisions of the players on both sides, as well as input data to the model. How the players believe various units should be used, has a considerable impact on the kill matrix. Thus, although such data are quantitative, they are not really more objective than a lot of the qualitative data.

Data such as the kill matrices also omits important information. One can see which units killed most of the opposing units, but the reasons why are lost. Other units, which did not directly destroy enemy units, may have been vital in creating the conditions for other units to be effective. Although certain units may have destroyed very few enemies, their presence on the battlefield may have been vital in preventing the enemy from conducting certain operations. For instance, the presence of close air defense may not cause said air defense to kill more enemy helicopters, but may have prevented the enemy from using helicopters as aggressively as he might otherwise have. Thus, when analyzing a wargame, one should be cautious about looking solely at quantitative data like the kill matrix. The whole picture must be taken into account.

Ideally, when comparing different force structures, several games should be conducted with each force structure, and the enemy should be allowed to alter his conduct in each game. Own forces should find the “best” way to utilize their structure in the given scenario, and the enemy should find the “best” way to counter this strategy. Only then can one compare the outcome of the wargames with different force structures, and conclude which force structure was most suitable for the given scenario. And then, of course, there are really a wide range of possible scenarios to consider. So, while this is perhaps how comparisons of force structures should be done, time and resources will usually be insufficient for the vast number of wargames needed in order to do so.

All models have limitations. They may be designed for a specific purpose, and be appropriate for that, but less suitable for other things. This is important to remember when considering what questions one can answer through wargames, and which questions should be looked at with different tools. Exactly what can be deducted from a wargame will depend on the model being used, but generally one should focus on the questions the experiment was designed to answer. If other results seem to emerge from the experiment, their validity should be examined, and the results often need to be evaluated in an experiment specifically designed to investigate these emerging questions.

Wargaming, as discussed in this paper, is a good tool for comparing the performance of two (or more) force structures in a given scenario. They do, however, not give any precise measure of the effectiveness of any given force structure, but will be suitable for identifying major strengths and weaknesses. Examining the importance of parameters for specific units, like fire power and armor, should in addition be examined in separate studies, as such factors, although important, are at a too detailed level for the types of wargames we discuss in this paper. “Wargaming is only one of the tools needed to study and learn about defence issues” (Perla, 1990). Other tools should be used to supplement the wargames and study the importance of such factors.

Wargames are often large events, involving a large number of people and taking a lot of time. Thus, we are usually restricted to a limited number of wargames – often only one for each force structure we are analyzing. It is important to remember that the outcome of one single wargame is just that: one possible outcome of the given situation. Things could have been done differently by actors on both sides, and events might have played out differently. Slight changes could affect the outcome of an event which was vital to the overall outcome.

SIMULATION SYSTEMS FOR WARGAMING

According to Peter Perla “[t]he key to realistic wargaming lies in balancing the player's experience in his decision-making role with as accurate a representation as possible of the physical outcomes of his own decisions, his opponents decisions, and the objective dynamics of combat” (Perla, 1990). Modern computer-based simulation systems include synthetic environments that replicate the physical properties of the real world and CGF that can autonomously execute battle drills and lower level tactics. Wargames have the potential to exploit these increasingly realistic interactive, simulation systems, but the simulation systems must be easy to operate for the players and require relatively few operators.

The simulation system we used when we first started with simulation-supported wargaming at FFI in 2010 was quite simple and suffered from several significant weaknesses. This often resulted in questionable simulation results. For example, the simulation systems did not support representation of micro-terrain features, and this systematically favored long-range, direct fire weapon systems. Additionally, the human behavior models for the SAF were very simple, and this required a lot of micromanaging from the players (Evensen et al, 2017; Evensen et al, 2018).

When we later wanted to establish a new capability for conducting more detailed, entity-level, constructive simulations to support wargaming at FFI, we found that traditional constructive simulation systems often were too complex and cumbersome to use, did not have the required level of resolution, or were not flexible enough with respect to representation of new technologies (e.g. new sensor systems, weapon systems, and protection systems). To satisfy our requirements, we are developing *webSAF*, an easy-to-use, web-based graphical user interface (GUI) for controlling semi-automated entities in constructive simulations (Evensen et al, 2017; Evensen et al, 2018). webSAF is tailored for two-sided wargaming and requires only a minimum number of operators on each side. Currently, webSAF is able to control semi-automated entities simulated in Virtual Battlespace (VBS) from Bohemia Interactive Simulations (BISim) and VR-Forces from VT MAK.

BEST PRACTICES

In this section we provide a list of best practices for conducting simulation-supported analytical wargames aimed at assessing force structures. Some of the best practices we have found are related to the need to handle the metagame, or the fight about the wargame. The usefulness of such best practices may be limited to other small nations that have not separated the power to invent from the power to test force structures. The other best practices stem from the need to provide simulation support to replace scenario-based structured discussions for defense structure development:

- **Define a clear objective:**
  A clear purpose for the wargaming experiments must be specified early in the preparation phase and will be the basis for the design of the experiments.

- **Use a simulation system customized for wargaming:**
  Having an interactive simulation system with SAF that is easy to operate for the players and requires relatively few operators reduces the resources needed for, and thereby also lowers the threshold for, conducting simulation-supported wargames.

- **Assemble a good Red team:**
  A good Red team is the key to discover weaknesses in own force structures, plans and procedures. The players on the Red team should also have good knowledge of the doctrine of expected opponents. We have observed that a good Red team quickly cured the tendency our own planners may have had to group-think possible enemy actions.

- **Allow the opposing force to adapt:**
  Change in the structure of own force must also allow change in structure of the opposing force. Change in force structures is a slow public process, and will certainly be observed by expected opponents.

- **Replicate the planning process:**
  Replicate the real-life planning process as closely as possible.

- **Observe the planning process:**
  Monitor the planning process to get a more complete picture of the strengths and weaknesses of a force structure. To document the deterrent effects of a Blue force structure, it is especially important to observe the planning process for the opposing force. Several elements in own force structures have been observed to have a deterrent effect on the operation of the opposing force. Presence and posture have also been observed to have a deterrent effect. Furthermore, we have observed that society, terrain and climate also influenced the planning of the opposing force.

- **Provide space and time:**
  Starting a wargame with forces in close proximity of each other may reduce the game to a simple game of attrition. Well-developed games, where space and time have been provided, flow like martial arts opponents maneuvering around each other, assessing each other’s weaknesses, and looking for

opportunities to strike. Assessing the ability to avoid an encounter may be just as important as assessing the ability to fight.

- **Allow uncertainty:**
Building a picture of what is happening takes time, and is a natural part of leading military operations. The true value of certain elements in a force structure only appears when uncertainty is properly represented. The force-in-being effect can for example be significant. Uncertainty is best represented when the tactical situation is not visible for all and the outcomes of the battle are perceived as non-deterministic to the extent that reality is stochastic.

- **Exercise vs. experimentation:**
Prepare the participants for the purpose of the wargame. When using command and staff trainers as the simulation system for supporting the wargame, some players tend to follow procedures as if it were an exercise. If the purpose of the wargame is to explore new force structure elements, new COAs or tactics, techniques, and procedures (TTPs), the players need to be encouraged to be creative when executing their tasks.

- **Keep high-ranking officers not participating in the game away:**
Keeping irrelevant personnel, especially high-ranking officers, not participating in the game away from the wargame itself is important. In HITL-simulations, the human players are part of the simulation as a whole, and visiting high-ranking officers (or others) will have an effect on the way the human players interact and how they conduct their plans. Limiting visiting personnel also reduces the chance of external influence on the results.

SUMMARY AND CONCLUSION

This paper has presented our methodology for simulation-supported wargaming and provided a set of best practices for conducting simulation-supported wargames. The methodology and best practices are especially aimed towards analytical wargaming to support capability planning.

The methodology consists of a preparation phase, a planning and execution phase, and an analysis phase. The methodology has gradually evolved over the last ten years by using more realistic simulation systems and by replicating and monitoring the planning process before the operation to gain more insight into the deterrent effect of the tested force structures.

Our best practices for conducting simulation-supported wargames includes defining a clear objective for the wargaming experiments, using a simulation system that is easy to operate for the players, having a good Red team that is not too restricted, providing space and time so that the war does not start immediately, and providing realistic representation of uncertainty and information gathering. Finally, to get a more complete picture of strengths and weaknesses of a force structure, it is important for the analysis group to observe the planning process in addition to the wargame itself.

Formalizing the separation of the power to suggest force structure changes from the power to test, evaluate and accept such changes would solve many of the problems we have seen in the defense planning. When supporting wargames with modeling, simulation and analysis, the metagame is seen as something that happens at a level higher in the hierarchy, and which we do not have any influence over. Our intention has been to raise awareness about these challenges and provide some adjustments in the part of the metagame that we can influence.

ACKNOWLEDGEMENTS

The authors would like to acknowledge everyone who has been involved in the planning, execution and analysis of the series of simulation-supported wargames for testing force structures conducted at FFI or the Norwegian Army Land Warfare Centre for the last ten years. We would also like to thank our I/ITSEC Birddog John Huddlestone for his helpful comments and suggestions during the process of developing this paper.

REFERENCES

Alberts, D.S & Hayes, R.E. (2002). *Code of Best Practice for Experimentation*, United States Department of Defense Command and Control Research Program.

Burns, S. (edited by) (2015). *War Gamer's Handbook: A Guide for Professional War Gamers*, Newport: United States Naval War College.

Chairman of the Joint Chiefs of Staff (CJCS). (2018). *Charter Joint Requirements Oversight Council (JROC) and Implementation of the Joint Capabilities Integration and Development System (JCIDS)*, CJCSI 5123.01H 31 August 2018.

Curry, J. & Young, M. (2018). *The Confrontation Analysis Handbook: How to Resolve Confrontations by Eliminating Dilemmas Innovations in Wargaming Volume 3*, The History of Wargaming Project.

Daltveit, E., Haande, T., Staurset, O., Bentsen, D.H., Martinussen, S.E., Halsør, M., Ajer, H. & Hoppe, U-P. (2016). *Rapport fra krigsspill til støtte for Landmaktutredningen (LMU) i Hærens stabs- og ledertrener i uke 49-50/2016*, [R], Rena: Hærens Våpenskole.

Daltveit, E., Enger, A.B., Tandberg, E., Haande, T., Martinussen, S.E., Hoppe, U-P., Bentsen, D.H., Kolbjørnsen, M. & Staurset, O. (2017). *Rapport fra Krigsspill til støtte for Landmaktutredningen (LMU) i Hærens stabs- og ledertrener i uke 12-13, 2017*, [R], Rena: Hærens Våpenskole.

Evensen, P-I. & Bentsen, D.H. (2016). *Simulation of land force operations – a survey of methods and tools*. FFI-report 2015/01579, Kjeller: Norwegian Defence Research Establishment (FFI).

Evensen, P-I., Selvaag, K., Bentsen, D.H. & Stien, H. (2017). Web-Based GUI System for Controlling Entities in Constructive Simulations, *Proceedings of the Interservice/Industry Training, Simulation and Education Conference (I/ITSEC) 2017*, Paper No. 17043.

Evensen, P-I., Selvaag, K., Bentsen, D.H., Holhjem, H.R., & Stien, H. (2018). Easy-to-Use, Web-Based Graphical User Interface for Controlling Entities in Constructive Simulations, *Proceedings of the NATO Modelling and Simulation Group (NMSG) Annual Symposium 2018 (STO-MP-MSG-159)*, Paper No. 7.

Grau, L.W. (1996). *The Bear Went Over the Mountain: Soviet Combat Tactics in Afghanistan*, Washington, D.C.: National Defense University Press.

Haande ,T., Tandberg, E., Kolbjørnsen, M., Daltveit, E., Staurset, O., Bentsen, D.H., Martinussen, S.E. & Hoppe, U-P. (2017). *Rapport fra Krigsspill til støtte for Landmaktutredningen (LMU) i Hærens stabs- og ledertrener i uke 5/2017*, [R], Rena: Hærens Våpenskole.

Hoff, E.Ø., Evensen, P-I., Holhjem, H.R., Øyan, I.B. & Nygård, H.K. (2012). Simulation in Support of Army Structure Analysis. *Proceedings of the Interservice/Industry Training, Simulation and Education Conference (I/ITSEC) 2012*, Paper No. 12088.

Hoff, E.Ø., Evensen, P-I., Holhjem, H.R., Øyan, I.B. & Nygård, H.K. (2013). Interactive Simulation to Support the Transition of Forces. *Proceedings of the NATO Modelling and Simulation Group (NMSG) Annual Symposium 2013 (STO-MP-MSG-111)*, Paper No. 6.

Martinussen, S.E., Tansem, I., Evensen, P-I., Rødal, H. & Bore, I. (2008). Simulation in Support of Defence Structure Analysis. *Proceedings of the NATO Modelling and Simulation Group (NMSG) Annual Symposium 2008 (RTO-MP-MSG-060)*, Paper No 22.

North Atlantic Treaty Organization (NATO) Standardization Office (NSO). (2000). NATOTerm – The Official NATO Terminology Database. Retrieved May 10, 2019, from https://nso.nato.int/natoterm.

Page, E.H. (2016). *Modeling and Simulation, Experimentation, and Wargaming - Assessing a Common Landscape*, The MITRE Corporation.

Perla, P.P. (1990). *The Art of Wargaming: A Guide for Professionals and Hobbyists*, Naval Institute Press.

Storr, J. (2009). *The Human Face of War*, Continuum.

United Kingdom Ministry of Defence (UK MoD). (2017). *Wargaming Handbook*, Swindon: The Development, Concepts and Doctrine Centre.

von Neumann, J. & Morgenstern, O. (1944). *Theory of Games and Economic Behavior*, Princeton University Press.

Yanoschik, T. (2016). Improving Capabilities Development and Acquisition through Wargames and Seminars, *Proceedings of the Interservice/Industry Training, Simulation and Education Conference (I/ITSEC) 2016*, Paper No. 16019.