13th International Command and Control Research and Technology Symposium

C2 for Complex Endeavors

User Perspectives on Design Logic in Military Training Simulators

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ABSTRACT

In our ICCRTS 2007 paper *'On Regarding 21st Century C2 Systems and their Users as Fallible ePartners'* we argued that there is a limit to what can be done to eliminate errors in C2 systems, and we should view human actors and the system together as electronic partners. The development and use of C2 systems has become, over the past decades, a complex area of inquiry with different thoughts on how to dominate in a coordinated fashion in warfare. Designers of increasingly sophisticated C2 systems follow a certain logic that becomes 'blackboxed' into the technology. We want to open this black box and investigate what decisions designers made and how users make sense of them.

We take the emerging field of Modeling & Simulation as our principal object of study. Technically sophisticated simulators have become an indispensable method for tactical military training. This study seeks to initiate a discourse on (dis)advantages, choices, interpretations and constraints associated with complex information systems in military modeling & simulation. To this end we are conducting a comprehensive, qualitative study on the use of a simulator for constructive training. This paper describes our research approach and summarizes our initial findings.

Keywords:

C2 Concepts; Theory, and Policy; Modeling and Simulation; Organizational Issues.

User Perspectives on Design Logic in Military Training Simulators

"We will regard artefacts as negotiated, embedded and sedimented sets of rules for goal oriented action" (Masino and Zamarian 2003: 694)

1. INTRODUCTION

1.1 Motivation

The objective of this study is to initiate a discourse on (dis)advantages, choices, interpretations and constraints associated with complex information systems in military Modelling & Simulation. In our ICCRTS 2007 paper *'On Regarding 21st Century C2 Systems and their Users as Fallible ePartners'* we argued that there is a limit what can be done to eliminate errors in C2 systems. We asserted that we should consider human actors and Information Systems as electronic partners – each one takes in account the fallibility of the other. The development and use of C2 systems has become, over the past decades, a complex area of inquiry with different thoughts on how to dominate in a coordinated fashion in warfare. Designers of increasingly sophisticated C2 systems follow a certain logic that becomes 'blackboxed' into the technology (Latour 1999); we will call that 'design logic' (see also (Orlikowski and Robey 1991)).

C2 systems are often simulated for training situations (van Veen, van Fenema et al. 2008). An example is the Action Speed Tactical Trainer (ASTT). The ASTT is an advanced training simulator for tactical operations of the Dutch Navy. The simulator is not just one terminal but a large floor with twenty cubicles each equipped with modern technology to simulate a command centre of a Navy vessel. When asked about the purpose of the training the instructor responded:

> *"The students obviously react to the games based on the teaching and the practice they have been told. The debriefings range from tactics played in best practice that was not followed by them to areas where there is no right or wrong option, but we may lead them to a different conclusion that is different from what they did in the game. The debriefings are very valuable and we are in the distinguished position of having God's picture in the kitchen. So we know what is going to happen and we know what they should consider and what they actually consider. And we will know duteously every bit of information that has been passed. And in their own set of cubicles, they have an idea what they want to achieve. Certain cubicles will have been passed different pieces of information, but all make the jigsaw come together. So we will know, whether or not they have information to make the right decision. And in the debrief we talk with everybody about that scenario, from all the different cubicles, to give them the full picture that we had all the time." (respondent 1)*

The similarities with the tale of the blind man and the elephant are striking[1] - reality may be viewed differently depending upon one's perspective. The training simulator enables Navy Command Centre Officers (CCOs) to execute complex tactical operations without the need of expensive resources and ‘real’ ships. Each sees a different part of the reality and they have to learn to communicate properly so that a ‘shared situational awareness’ is created (Perla, Nogfi et al. 2000; Endsley and Jones 2001), i.e. the different commanders understand the situation in the same way.

In military training instant understanding of complex situations is essential. Sounds, lights, maps, screens and images play a very important role for achieving this goal. Therefore the terminals in the training simulators look exactly the same as on the ships. Everything is according to the commander of the ASTT ‘*copied as much as possible*.’ The buttons and options are the same. The whole ‘look and feel’ of the military training operation provides a very real experience. While visiting this simulated environment we experienced a sincere tension amongst participants to excel. The highly concentrated CCOs were monitoring their screens and communicating over the radio. However, the training environment can not perfectly replicate experiences as on the ship - there is no real threat, no stormy weather, the other command centres are physically speaking in the crucible next door, and there is a coffee break at eleven.

Technically sophisticated simulators have become an indispensable method for tactical military training. All sorts of simulators are available, for example for firing weapons, driving tanks, flying combat aircraft, simulating large battles, performing medical operations and making tactical assessments. This raises many important issues concerning the testing, verification and validation of simulators. Moreover, the extent to which simulators represent ‘truth’ is an important theme, as well as the relation between representation and reality. Since military training has become very dependent on simulators, any ramifications from these issues are considerable.

1.2 Purpose & Scope

The development of a military training simulator involves three steps: developing the models, and building and using the simulator. The developers of the models take many decisions on how to model (military) objects, shaping the ‘deep structure’ of the system (Beath and Orlikowski 1994). Whilst builders make many decisions on how to implement the model, users appropriate the system to their context (Orlikowski 2000). Through these processes assertions, decisions and verification are consciously and sub-consciously ‘coded in’ the simulator. Latour would argue that building a simulator is a process in which social scientific practices eventually lead to the final product. The developers working on the models and building the system are working in accordance with their accepted procedures and standards, which does not represent a pure logical process (Latour, 1987).

We focus our research on what is being represented in tactical military training simulators, some of which years to be developed leading to these artefacts becoming deeply embedded. The

[1] In the tale a group of blind men touch an elephant to learn what it is. Each one touches a different part: leg, ear, trunk and tail. When the blind men compared their experiences they discovered that they were in complete disagreement.

objective of this study is therefore to initiate a discourse on (dis)advantages, choices, interpretations and constraints associated with complex information systems in military modeling & simulation. Specifically we are interested in analyzing the simulator as a representative of military training and developing methods for doing so.

Conceptually, our study starts from the assumption that tactical military simulators constitute a materialization of assumptions about war. We are interested in the relationship between military training simulators and what they represent. To this end we attempt to 'open the black-box' (see (Latour 1999)) and focus on the difference between the artefacts-in-use and the artefacts-in-development (Orlikowski 1992; Orlikowski 2005). This gap is also known as 'the leap of faith' (Taylor, 1986). Taylor argued that a certain amount of trust is needed when using information systems, both in the designers of the system and its content. Our empirical research is conducted on the Action Speed Tactical Trainer (ASTT) for training Naval command centre officers.

This paper consists of six sections, including this introduction. Section 2 reviews the phenomena military training simulators and reviews the current discussion about verification, validation and accreditation. To put it in perspective Section 3 identifies two examples of 'simulator critique' that helps us to formulate our research approach (Section 4). We then present a preliminary case-study (Section 5), before we conclude with a discussion regarding the way ahead with our research approach.

2. MILITARY TRAINING SIMULATORS: VERIFICATION AND VALIDATION

James Der Derian contends that military training simulators play an important role in the military-industrial-media-entertainment network (Der Derian, 2001). In this section we provide a short overview of phenomena to illustrate the (design) complexity of these products.

2.1 Categories of simulators

Military training simulators exist in many shapes and sizes. In 1992, the Defence Science Board defined three major categories of military simulators: constructive, virtual and live simulators (Page & Smith, 1998), although recent progress has blurred these boundaries.

1. Constructive training simulators involve simulated people operating in simulated systems. Real people stimulate (make inputs) to such simulations, but are not involved in determining the outcomes. Examples include war games that improve command and staff level decision making. The ASTT, where a geographical area is mapped, is an example of a constructive training simulator.

2. Virtual simulation involves real people operating simulated systems. Virtual simulations inject human-in-the-loop in a central role by exercising motor control skills (e.g. flying an airplane), decision skills (e.g. committing fire control resources to action), or communication skills (e.g. as members of a C4I team). The Dutch army is currently building Tactis - a large training simulator with mock-up tanks operating within a virtual environment. Virtual simulation mostly offer a 3 dimensional representation of a 'real' world in which one can move around.

3. Live simulation involves real people operating real systems and staging of mock combat experiences in a relatively safe environment. The Dutch Army uses the Saab Mobile Combat Training Centre (MCTC)[2] that makes it possible to monitor exactly the troop movements and 'hits' during a large scale (physical) training exercise. Such a system can simulate bullet trajectories, artillery fire, mines, damage on tanks, and so on. Systems for live simulations are very sophisticated and can be very useful for debriefing of military exercises.

The Defence Science Board was well aware that this classification system has its problems (DoD, 1997). The systems are more and more integrated and the already vague borders between the types are disappearing. Nowadays is has become challenging to categorize computer games within these domains, because they can simulate almost every type.

Roger Smith (2007) developed a generic conceptual model that identifies the 'common components' of military simulators (Table 1). This model has its flaws (its terminology is not always clear, the relationships are somewhat vague, it assumes a network of simulators linked together), but it illustrates the complexity of the military training simulator.

Term	**Explanation**
Hardware	- Hardware is a general term that refers to the physical artifacts of a technology.
Networks	- A computer network is an interconnection of a group of computers. Networks may be classified by what is called the network layer at which they operate according to basic reference models considered as standards.
Operating System / Programming language	- An operating system (OS) is the software that manages the sharing of the resources of a computer and provides programmers with an interface used to access those resources.
Distribution Management	- Distribution management enables software components written in multiple computer languages and running on multiple computers to work together.
Event management	- Receives messages, distributes and check them during events, for example an explosion.
Object Management	- Status of objects within the simulator, where are they and what is their status.
Time Management	- Managements of time, for example how to deal with several instantaneous events. Synchronisation.
Simulation Management	- Management of simulation. Start and stop of simulation. Logging and so on.
Synthetic Environment	- Static environment – virtual world. Databases that hold information that can be accessed by models or other simulation tools. The data

[2] See http://www.military-training-technology.com/article.cfm?DocID=2060

	does not change. Ensures that each player sees the same synthetic environment.
Models	- Dynamic elements in virtual world. Core of the model is the State Set, the attributes which define the existence and capabilities of the objects.
User Interfaces	- Delivers simulation data to human users. How human connect with the system.
Translators	- Delivers simulation data to other systems. How systems communicate with other systems.
Data Management	- Data Management is drawn along the site of the diagram because it may be accessed by any of the layers at different times in the lifecycle of the use of the simulation application.

Table 1: Simulation Software Components (Smith, 2007).

Military training simulators have many benefits in comparison with ordinary military training. Its is cheaper than a regular military training exercise: it saves time to set up, uses no petrol, uses less terrain, opposing forces can be simulated and so on. Much more different skills can be trained, for example driving in all kinds of weather in just one day. Training sessions within the simulator have much less impact on social and environmental issues. Despite all the advantages most instructors argue that simulators cannot replace regular military training completely.

2.2 Verification and validation

The development of military training simulators is a very complex process, and it is understandable that verification is given high priority. Purchasers, users and trainers want to eliminate errors and ascertain that the quality of the training tool is sufficient. In principle simulators can produce two different types of errors (Quinn, 2005). Either the software itself is flawed and contains bugs or code errors or the real system is imperfectly modeled. Verification is the process that checks on software errors and focuses on the question whether simulation specifications are met (building the simulation right). Validation is the process that is focused on the simulation representation (building the right simulator).

In the development process of simulators both issues should be addressed and documented, however it can prove difficult to validate simulators. Whilst one way is to achieve validation is to compare the behaviour of the simulator with the behaviour of the real object, such validation is only valid for the assessed experiments and criteria, which may not cover the ful range of desired uses (e.g. environment conditions, threat conditions). This problem expands when it is considered that many simulators predict future behaviour and it is not always possible to wait for the future to happen. This kind of model are largely validated by ‘predicting the present’, but of course there is always a degree of uncertainty. Where such techniques are not applicable (or unaffordable), experts are used to test the simulator by gathering data and make ‘educated guesses’ whether the results are ‘right’. If the simulators behave in accordance with the expectations they are considered validated, gain credibility and are accredited.

The Department of Defence established in the 1990s the Defense Modeling and Simulation Office (DMSO)[3] that encouraged project leaders to be (more) aware of the importance of verification and validation issues. In 1996 they formulated twelve principles in the report 'Verfication, Validation, and Accreditation Recommended Practices Guide' (DMSO, 1996).

1. *There is no such thing as an absolutely valid model.*
2. *VV&A should be an integral part of the entire M&S life cycle*
3. *A well-formulated problem is essential to the acceptability and accreditation of M&S results.*
4. *Credibility can be claimed only for the intended use of the model or simulation and for the prescribed conditions under which it has been tested.*
5. *M&S validation does not guarantee the credibility and acceptability of analytical results derived from the use of simulation.*
6. *V&V of each submodel or federate does not imply overall simulation or federation credibility and vice versa.*
7. *Accreditation is not a binary choice.*
8. *VV&A is both an art and a science, requiring creativity and insight.*
9. *The success of any VV&A effort is directly affected by the analyst.*
10. *VV&A must be planned and documented.*
11. *VV&A requires some level of independence to minimize the effects of developer bias.*
12. *Successful VV&A requires data that have been verified, validated, and certified.*

The twelve principles formulate a vision on how verification and validation can be realized. Of interest is the first sobering rule: 'There is no such thing as an absolutely valid model.' The other rules are conditions for maximizing validity. This work had a high impact on the modeling & simulation community and created valuable practices that where adopted within the community (Martis, 2006). Recent work has developed extensive toolboxes on how to evaluate simulators (Cook & Skinner, 2005).

2.3 Extending verification and validation of simulators

So far, the 'verification, validation and accreditation' (VV&A) process focuses very much on the correctness of the simulation by formulating criteria for comparison. The simulator is tested these criteria and then the expected results are compared with the factual results. If we take, for example, the behaviour of a tank (X) and a simulated tank (Y). Then our simulator behaves correctly if X behaves the same as Y. This, of course, assumes that it is possible to specify aspects of behaviour, measure these and compare them. In many cases we are able to do this sufficiently, but only on the aspects that are explicitly specified, modeled and coded in to the simulator. However, simulators that offer a 'virtual world' - a copy without an original - can only be tested partially. '*Simulations are defined in terms of models; they don't test the relationship between the model and world. That is exactly why simulations and tests can never replace embedding a program in the real world.*' (Cantwell Smith, 1985)

[3] http://www.dmso.mil/

However, there is another, more subtle, issue. Complex simulators are built in complex and sometime long-term development projects. During these projects many design decisions are made to make the system work. Of course, in all these decisions, the complexity of the reality has to be abbreviated (Cooper, 1992). These necessary decisions are taken in accordance with the specifications and requirements, but when the system is ultimately delivered – assumptions, decisions, ideas have all become blackboxed for the end-users. Un-blackboxing these encapsulated ideas is important to make decision makers and users aware of the advantages and limitations of their training environment. Few authors have reflected on simulators and military thought. In the next paragraph we describe two examples of 'black-boxed' ideology in military (training) models, first from an international-relations perspective (Der Derian) and second from a historical perspective (De Landa).

3. SIMULATOR CRITIQUE

This section reviews philosophical concepts that relate to our study and will guide our simulator critique. In the first paragraphs we introduce the ideas of James Der Derian that include the viewpoint that by representing the complex world in military training simulators, many political issues might be unintentionally have become embedded as well.. The later paragraphs discuss the ideas of Manuel De Landa who argues that by defining a model many assumptions about warfare become implicitly encoded. In their work, both authors pay specific critical attention for military modeling and simulations.

3.1 Der Derian

James Der Derian has extensively written about politics, war and technology inspired by scholars as Benjamin, Virilio, Baudrillard, Nietzsche and Deleuze. His latest book is 'Virtuous war: Mapping the Military-Industrial-Media-Entertainment Network' (2001) probes the following theme: 'Is virtuality replacing the reality of war?' He presents his analysis as a travelogue in which he visits together with the reader many different training exercises and military commanders. He puts his readers *'virtually inside the war machine, to experience its power and seductions...'. (Der Derian, 2001).* His inductive argument seeks to unravel the relationship between war and technology.

'Operation Desert Hammer VI' is one of the first training exercises described. This exercise was presented to the press '*how digital technology can enhance lethality, operations tempo and survivability across the combined arms team in a tactically competitive training environment*' and showed the improved M1A2 Abrams main battle tank, carrying an IVIS to collect real-time battlefield data from overhead JSTAR aircraft, UAVs with video cameras and a GPS to display red and blue forces on a computer-generate map. Der Derian puts the usage of technology in a political and ethical perspective. In his opinion 'realism has become virtual' and many assumptions about war, peace and politics have become 'convenient fiction'.

New technologies are changing the nature of politics, but theory and ethics are not keeping pace. Technology has an impact on how humans experience and perceive the world. Realism assumes a 'sameness of motives' in human nature and geopolitics - it assumes that someone living in Afghanistan has the same needs, values and perception as someone living in the Netherlands:

‘*By making ways of being and ways of knowing one of the same, Benjamin shows us how questions of violence have always been problems of identity. In the absence of alternative modes of knowing, when a whole people become a ‘problem’, violent final solutions can result.*’ (Der Derian, 2001). Being a friend or foe has become a matter of category; a label. But falling in a certain category has a political effect. Technology makes new representations possible and it mere existence has political effects.

In conclusion Der Derian argues that “*Virtual theory finds a home in the interzone, where the retrieval of facts – empirical or social – is preceded by interpretation, conveyed by technical media, conducted through experimentation, and succeeded by the creation of new virtualities. Both war and peace are still in need of approaches that study what is being represented. But it is also in need of a virtual theory that can explore how reality is seen, framed, read, and generated in the conceptualization and actualization of the event.*”

Main points of Der Derian
Realism is ‘convenient fiction’
The world is complex to ‘catch’ in simple labels
Technology has political effects
Virtualization has an impact on international-relations

Table 2: Main Points of Der Derian

3.2 De Landa

In his book ‘War in the Age of Intelligent Machines’ De Landa investigates the relationship between war and technology. He describes long-term historical phenomena but avoids an anthropocentric conception of history. He considers especially the interactions between what he calls ‘the war machine’ and ‘the machinic phylum’ based on concepts borrowed from Deleuze & Guattari, Foucault and Braudel. *‘The machinic phylum, seen as technology’s own internal dynamics and cutting edge, could still be seen shining through the brilliant civilian discoveries of the transistor and the integrated chip, which had liberated electronic circuit designs from the constraints on their possible complexity. But the military had already begun to tighten its grip on the evolution of the phylum, on the events happening at its cutting edge, channeling its forces but limiting its potential mutations.’ (De Landa, 1991)*

Long-term historical developments are identified by constantly focusing on the interaction between technology and military applications. Whilst the achievements of historical figures and the technological developments are important, it is the combination of both that prove decisive. De Landa shows how technological development leads to new ways of warfare and two opposite perspectives on warfare are highlighted: the Jominian and the Clausewitzian.

Jomini favors military affairs over diplomacy and politics. The Schlieffen Plan is a good example of this: ‘*The Schlieffen Plan called for a surprise encircling attack against the French army, an attack so perfectly coordinated it would deprive the enemy of any military options, thus making negotiations unnecessary...The same technology that allowed Schlieffen and his successors to design their ‘perfect’ plan is today one of the main forces separating military might from diplomatic skill: war games.*’ (De Landa, 1991). De Landa argues that the Jominian approach is currently dominant and has created a certain bias He argues that since World War II scenarios of nuclear war were pro-conflict *'behind a facade of mathematical neutrality'* and that international cooperative behaviour follows with the 'Prisoner's Dilemma'. This paradigm was developed by the RAND cooperation in 1950 and assumes two parties who mistrust each other and betrayal is the only (safe) rational option. In the war models this leads to nations that betray each other and build nuclear arsenals.

In pursuit of our research objective we are interested in the assumptions underpinning these war games, the communication of these assumptions to users, and user interpretation of these assumptions. This represents a designer-user dialogue (Klein and Sorra 1996; von Hippel 1998) that is lacking due to – amongst others things– the nature of packaged software (Lucas, Walton et al. 1988; Sawyer 2000). In military simulation, firstly, we should assume that the choice between betrayal and cooperation does not have to be made once, but can be made several times in the relationship. Secondly, we should assume that there is not only one prisoner, but many prisoners to trade with.

De Landa goes to great length to explain the experiment of political scientist Robert Axelrod. He demonstrated that '*A majority of programs simulated 'traders' who were out to exploit other traders (reflecting the traditional pro-conflict bias), while other programs simulated traders who were willing to cooperate. Surprisingly, the 'winners' of this competition were programs that emphasized cooperation. 'Winning' was not defined as defeating rivals in single encounters (in which case betrayers would have won), but in maximizing the benefits of trade. In this situation, programs that tended to betray quickly ran out of partners with whom to trade, since one betrayal would start a vicious circle of counter-betrayals and mistrust. In the long run the winning programs were the ones that had the following characteristics: they were not out to exploit other programs; they retaliated in kind after being betrayed; and they were willing to establish a relationship after retaliating*'.

For De Landa this is a very important insight because the development of war games is running into the 'exact opposite direction'. He argues that the tendency is to take the human 'out of the loop' in military decisions, because of the unreliability of human beings. Decision making of self-firing weapons and autonomic technology of war will drive was to become a pure technical, mathematical event. The human would be out-of-the-loop and responsibilities would become unclear[4]. At the other end of the spectrum stands the Clausewitzian approach which emphasis the pre-eminence of politics over warfare. This involves human staying in the loop and the need to include 'the enemy's will' as a variable in any strategic decision..

De Landa is afraid that when war games become too rigid the space for such 'political maneuvering' disappears. Jominian war games are highly computerized, developed by mathematicians, and humans are taken out-the-loop. In the most 'pure' form, the war games are fought by computers and generate data that are impossible to obtain from real battles. Social-scientists prefer Clausewitizian war games: in this games usually a political crisis is simulated

[4] See also *Future Warfare and the Decline of Human Decisionmaking* http://www.carlisle.army.mil/usawc/Parameters/01winter/adams.htm

with role playing. The participants play an active role and try to decide what they should do with the given information.

De Landa identifies three problems common to war gaming. Firstly, it is very difficult to 'think red'. No one knows how the enemy will respond to certain actions. The models that predict enemy behaviour can only be based on historical data and educated guesses of the modelers. Secondly, the data that goes into the model is often corrupted. For example the specifications of the performance of weapons are often manipulated for budgetary and political reasons. Sometimes when the 'mistakes' are discovered it forces the army to falsify the reports. Third, the war games present a very realistic picture '*there is the danger of war games evolving from their 'insight-producing' role into a 'crystal ball' role, where they are used to derive predictions about the future.*' Hence, different approaches can have implications for military simulations.

Main points Jominian	**Main points Clausewitzian**
Centralistic command Human is fallible and is taken out-of-the-loop Tries to discover mathematical laws in war Zero-sum games	Room for political deliberations Human must stay in the loop Politics prevails over military Strive for cooperation
Consequences for military simulators: - models become too rigid - winning or losing are the only two options - always two parties fighting against each other	Consequences for military simulators: - negotiations are an important part of warfare - their are alternatives for winning and losing - enemies and friends can change roles

Table 3: Clausewitzian versus Jominian Approach to Military Simulations

4. RESEARCH APPROACH

In this section we describe our research approach to help us understand how representations in military training simulators work. De Landa and Der Derian guide us to find relevant questions, noting that there are some important differences between both authors. De Landa looks to long-scale historical developments and has produced a deductive analytical argument. Der Derian is much more event- oriented and ties the current military and technological developments together to get a better understanding of international relations.

De Landa and Der Derian raised both fundamental questions about the validation of military (training) simulators, they are highly original in their thinking, without regard for conventional issues in the field of verification and validation. They emphasize the entangledness of technology with social and moral behaviour. Technology cannot be seen as separate from humans and vice versa - humans develop technology, but technology also shapes humans. Both would argue that technology is not a pure rational 'thing' and try to avoid the traps of determinism and techno-phobia.

	Der Derian	**De Landa**
Relevant question for simulators	Virtuality versus reality Representation of complex concepts Political impact of technology	Assumptions in models Human decision making Quality of data
Similarities	Human and technology are interrelated Overcome Subject-object distinction	
Differences	Current events Inductive approach Plea for new theory Political-ethical Personal	Historical analysis Deductive approach Reflection on warfare Materialistic Abstract
Missing	Suggestions how to develop the new theory	Theory for developing such an theory

Table 4: Comparison De Landa and Der Derian

De Landa and Der Derian develop a critique on the relationship of war and technology, raising issues about the relationship between simulations, reality and war that we consider as the core of our research project. We will continue this work with the following simple conceptual model in mind.

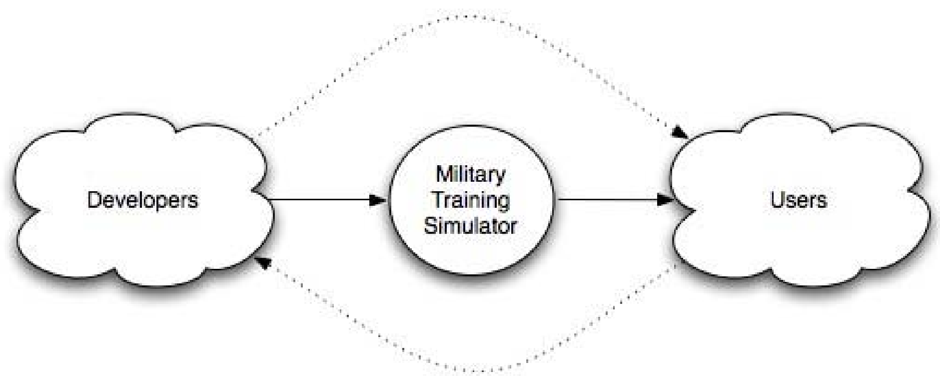

Figure 1: The relationship between developers and users

We make a distinction between developers and users. We will investigate how users 'make sense' of the military training simulator by interviewing them about the application and visiting training exercises. This will lead to a descriptive study on the vocabulary, assumptions, strengths (and so on) of the military training simulator. In parallel we will investigate the developers' perspective. We want to interview them about their considerations when using, building and testing the simulator. We are interested in the choices they made (i.e. design logic). The practices of both the users and developers will be compared. Moreover, we want to know how certain design logic is translated in user perceptions. Probably the vocabulary of Latour could be very useful (e.g. practices of translation, blackboxing, composition and delegation)

5. CASE STUDY ASTT

In this section we present our initial case-study of the ASTT[5]. The results are preliminary (we expect that this study will at least take another year) and only represent the 'user perspective'. This tentative case-study is the result of six in-depth interviews, two site visits of training exercises and we also studied some relevant policy and educational documents. More visits and interviews are pending.

Naval command centre officers are being prepared with ASTT for peacekeeping missions overseas at the Dutch Navy. The simulator is not just one computer but a large floor with twenty cubicles each equipped with modern technology to simulate a command centre of a Navy vessel. It is possible for twenty command centers to participate in the mission on that location. The small crucibles replicate the terminals in the command centers on the ships - the participants can monitor their radars (air, surface and submarine), cooperate with other ships and act in accordance with the scenarios the course leader has developed for them. These command centers exist in virtual space only, but offer a very 'realistic' experience.

Figure 2: Inside look of a crucible

The ASTT is used in several courses. We visited the training for the basic course for Command Center Officer (CCO), a program that takes 14 months. The CCO should be able to assess tactical situations and command tactical operations. The exercise has an increasing level of difficulty. There is a build- up in: single, dual and multiple threat games. We visited the first of the multi threat games (most difficult). The simulations served a double purpose: on one hand it is an exercise to train certain skills, on the other the students were also assessed on how they performed. The ships are fully equipped with advanced radar-systems, communication systems and so on, but to make 'building a operational picture' a bit harder the AWACS were not fully functional. Therefore it was not possible to identify and follow all enemy ships directly. The CCO has to send out ships or helicopters for visual identification if the enemy parties where beyond the range of the ships radar.
We spoke with one of the instructors of the exercise and an excerpt is given below

[5] See http://www.thales-naval.com/naval/activities/combat-sys/other-activities/astt.htm

Question: What is the purpose of the debriefing?
Answer: The objective is to focus the students and allow them to develop. A lot of the scenarios that we have, contain incidents they will encounter further down the line in a more complex environment. So because they have a single threat game initially and we will refine procedural things, we can also try develop their trains of thought to a more tactical aspect. And then it will develop into a dual threat game, hopefully they have retained some of the single threat to become instinctive. So that they will be able to develop themselves in the dual threat. And ultimately when we go to the multi threat itself, they have got to be at a stage where some things are instinctive, because you can't remember everything or try to recall everything. Things have to be instinctive. So the ultimate goal of these debriefs is to give them some instinctive things. They don't have to retain everything, things will happen. And it will allow them more capacity to deal with the more complex scenarios. (respondent 1)

Considerations of 'procedural things' and 'instinctive' feature prominently. Whilst the training against a single threat is aimed at refining the knowledge of procedures, it is also – on a higher level - aimed at developing tactical insight, and most importantly this insight is to become 'instinctive'. The combination of thinking, insight and instant responses are very important in this training environment. It is also noteworthy that students are prepared to function in 'a more complex environment'. The environment of the game makes the behaviour of students very transparent and assessable, because the instructors have access to ground truth.

We also spoke with the leader of the training and an excerpt is given below.

Question: How did it go?
Answer: As expected. The game was played as I expected. Relatively quiet. Some instructors complained that everything was too quiet. But you can watch the entire process of the students, the scheduling, the staff work they wrote, the orders and the execution. Because the execution of the scenario takes the whole day, it is not necessary to start shooting at minute one. It is a game and when you are playing a game yourself you want to shoot as quickly as possible, but that has not been the most important part here. (respondent 2**)**

Question: The scenario you sketched this morning was somewhat different from the performance during the exercise. The exercise was actually meant to be a quiet ride accompanied by an occasional warning, during which not much would happen, however, during the day tensions rose. Even some shooting incidents occurred.
Answer: Yes, what happened today is that we had anticipated their plans, but expected them to respond sooner to enemy movements. The ships they had to protect, eight or so, transported at least four thousand marines who later had to make an invasion. I had expected that they would have tried to keep the enemy forces further away. In the leading student's assessment he expected probing missions and wanted to warn them to stay away. But he did not say that he would let them come overhead and beside the ship. If I were a task forces commander I would not want that to happen. He had this plan in his head, but during the execution he did not expect this to happen. I was in a position to do almost

> anything and he did not see it as an enemy threat, he just continued his way. He thought I only would do something if they started shooting. Yes, that is too late. During lunch we (the trainers) discussed the matter and asked ourselves when they were going to respond, we expected that the incidents would already have triggered it. If we would have continued the same way as this morning then we could have passed him with all the enemy fighters, submarines and ships and he still would have done nothing. We could have got beside him throwing eggs and he still would have done nothing. He had to protect four thousand marines which should have been taken into account. One must draw a line not to be crossed by units that have already conquered a piece of land. A distance of 200 yards is out of the question. (respondent 2)

Here we see an interesting progress in the development of game. ‘Shooting’ is ‘not necessary’ when playing a simulation. But on the other hand the students have to be provoked to see how well they respond on enemy threats. The environment and possibilities of the game create a setting to make things happen.

We also had a short interview with one of the students and an excerpt is given below.

> **Question:** Do you experience an emotional involvement during the game? Are you more tensed when the pressure grows?
> **Answer:** Yes, that is absolutely true. There are several issues here. One is the situation where you are in. Yes you enter into your scenario, but you know it is not real. I can imagine that in reality one could experience more stress. You also have to work with the communication discipline, what happens in this ‘line’. Is this continuously ‘filled up with irrelevant communications’, then it is very difficult to get your message across. One would like to pass on information, but you have to wait, and wait and wait. That is an annoying situation when you want to pass your information. Especially when you are a warfare commander and you need to pass on this information to your group members: what are your intentions, what are your assessments... It is very important to get that space. Of course the other reports are also needed and important, but it creates a new level of stress. All these things raise the level of stress in the cubicle... and sometimes you have an instructor standing behind you saying did you think about this, did you think about that. (respondent 3)

The student agrees with the idea of emotional involvement and links that to experiencing ‘stress’ and pressure. Waiting in a period of stress is frustrating: one has to be able to act immediately. The right information has to be passed around, but reflection (of the instructor) can be quite annoying in such a situation and may increase the experience of stress. He knows the scenario is ‘not real’, but the distinction between reality and virtuality is no matter of concern when being involved on such a level.

In just these short transcripts we are already in a position to notice many interesting things about the user’s perspective. The issue of technology plays no explicit role here. Technology is transparent, works and provides a convincing picture of reality. No one asks questions about the validity of what is being represented on the screens. Rightly so because every one is very much involved in playing the scenario, but the scenario is set up in such a way that something must happen. Also it is worth noticing that the vocabulary of the computer games is taken over, one speaks of ‘God’s view’, ‘gaming’, ‘shooting’ the same way as we were playing a game. The game has its own special rules about procedures, enemy objects, threats and political context, (as per Der Derian 2003).

In relation to our research question these notions help us to understand how the objects are understood when we talk about the military training simulator. This helps to examine *how* these systems represent objects and events through models and consider what the implications are in doing so. As a matter of course the next step would be to talk with other participants about the degrees of freedom one has in setting up scenarios and developing trainings with the ASTT and how this is related with the assumptions the designers had when developing the system.

6. WAY AHEAD

The aim of the research project is to open the black-box of military training simulators. We take a ‘constructive’ position in which the interconnectedness of human and non-humans is assumed (Latour 1999) and try to initiate a debate on the quality and validity of military simulators. Crucial is the question how simulators represent objects through models and what the implications are of doing so. To accomplish this we are developing a case-study and strive to conduct one case-study for each type of simulator.

Further work, will ‘follow the actor’ and describe what is going on during a training exercise. We will visit training sites, study relevant documents (manuals, training programs, policy plan, and so on) and conduct in-depth interviews - talking with users, developers, commanders, maintenance staff and so on. Using the work of De Landa and Der Derian as a guide, we will identify the ramifications of black-boxed artefacts. This work is timely now that simulation in warfare has become common.

7. ACKNOWLEDGEMENT

We would like to thank our students Frusch & Hereijgers for transcribing the interviews. We also would like to thank David Lowe for his valuable editorial suggestions. An earlier version of this paper was presented at Technology in Wartime at Stanford Law School, organized by Computer Professionals for Social Responsibility (CPSR).

8. REFERENCES

Beath, C. M. and W. J. Orlikowski (1994). The Contradictory Structure of Systems Development Methodologies: Deconstructing the IS-User Relationship in Information Engineering. *Information Systems Research* 5(4): 350-377.

Cantwell Smith, B. (1985). The Limits of Correctness. *ACM SIGCAS*, *14, 15*(1,2,3,4), 18-26.

Cook, D. A. & Skinner, J. M. (2005). How to Perform Credible Verification, Validation, and Accreditation for Modeling and Simulation. *CrossTalk*, May, 20-24.

Cooper, R. (1992). Formal Organization and Representation: Remote Control, Displacement and Abbreviation. In M. Reed & M. Hughes (Eds.), *Rethinking Organizations New Directions in Organizational Theory and Analysis.* London: Sage.

Der Derian, J. (2003). Was as game. *The Brown Journal of World Affairs,* X(1), 37-48. Der

Der Derian, J. (2001). *Virtuous war: Mapping the Military-Industrial-Media-Entertainment Network.* Boulder, Colorado: Westview Press.

De Landa, M. (1991). *War in the age of intelligent machines.* New York: Swerve Editions.

DMSO, (1996) The Principles of Verification, Validation, and Accreditation. In: *Verification, Validation, and Accreditation Recommended Practices Guide,* U.S. Department of Defense, Office of the Director of Defense Research and Engineering, November.

DoD. 1997. *DoD modeling and simulation (M&S) glossary*, U.S. DoD 5000.59-M.

Endsley, M. R. and W. M. Jones (2001). A Model of Inter- and Intrateam Situation Awareness: Implications for Design, Training, and Measurement. New Trends in Cooperative Activities: Understanding System Dynamics in Complex Environments. M. McNeese, E. Salas and M.

Endsley. Santa Monica, CA, *Human Factors and Ergonomics Society*: 46-67.

Klein, K. J. and J. S. Sorra (1996). The Challenge of Innovation Implementation. *Academy of Management Review* 21(4): 1055-1080.

Latour, B. (1987). *Science in Action: How to Follow Scientists and Engineers through Society*. Cambridge, Massachusetts: Harvard University Press.

Latour, B. (1999). *Pandora's Hope: Essays on the Reality of Science Studies*. Cambridge, MA, Harvard University Press.

Lucas, H. C., E. J. Walton, et al. (1988). Implementing Packaged Software. *MIS Quarterly* 12(4): 537-549.

Martis, M. S. (2006). Validation of Simulation Based Models: A Theoretical Outlook. *The Electronic Journal of Business Research Methods, 4*(1), 39-46.

Masino, G. and M. Zamarian (2003). Information technology artefacts as structuring devices in organizations: design, appropriation and use issues. *Interacting with Computers* 15: 693-707.

Orlikowski, W. J. and D. Robey (1991). Information Technology and the Structuring of Organizations. *Information Systems Research* 2(2): 143-169.

Orlikowski, W. J. (1992). The Duality of Technology: Rethinking the Concept of Technology in Organizations. *Organization Science* 3(3): 398-427.

Orlikowski, W. J. (2000). Using Technology and Constituting Structures: A Practical Lens for Studying Technology in Organizations. *Organization Science* 11(4): 404-428.

Orlikowski, W. J. (2005). Material Works: Exploring the Situated Entanglement of Technological Performativity and Human Agency. *Scandinavian Journal of Information Systems* 17(1): 183-186.

Page, E. H. & Smith, R. (1998). *Introduction to Military Training Simulation: A Guide for Discrete Event Simulationsist*. Paper presented at the Proceedings of the 1998 Winter Simulation Conference, Washington, DC.

Perla, P. P., A. Nogfi, et al. (2000). Gaming and Shared Situation Awareness (CRM D0002722.A2/Final). Alexandria, VA, Center for Naval Analyses.

Quinn, M. J. (2005). *Ethics for the Information age*. Boston etc.: Pearson Addison Wesley.

Sawyer, S. (2000). Packaged Software: Implication of the Differences from Custom Approaches to Software Development. *European Journal of Information Systems* 9(1): 47-58.

Smith, R. (2007). *Military Simulation: Techniques and Technology : Course Handbook : Essential Concepts for Simulation Interoperability, Architectures, Models, and Applications*. Orlando, Fl.: Distributed Simulation Technology.

Taylor, R.S. (1986). *Value-Added Processes in Information Systems*. Norwood, NJ.: Ablex Publishing.

van Veen, M., P. C. van Fenema, et al. (2008). Military Simulations and Socially-Responsible Computing: An Uneasy Alliance? Technology in Wartime, Stanford University, Palo Alto, CA.

von Hippel, E. (1998). Economics of Product Development by Users: The impact of "Sticky" Local Information. *Management Science* 44(5): 629-644.

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